NAVAL POSTGRADUATE SCHOOL

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THESIS

**AUTOMATION OF THE MARINE
CORPS PLANNING PROCESS**

by

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June 2014

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13. ABSTRACT (maximum 200 words)

In today's world, innovations in software have provided organizations a platform to establish a collaborative environment that leverages new technologies. The Marine Corps is not immune from these innovations and must look at current innovations that can link current systems to decision makers. As today's technology has advanced, the Marine Corps' duty is to influence innovations to provide a collaborate environment. This collaborative environment, specifically command and control (C2) systems, must facilitate information retrieval at all levels while maintaining the authoritative integrity. This thesis provides information about Planning Application Extension (PAE), a collaborative software currently employed within Marine Air Ground Task Force (MAGTF). Furthermore, this thesis examines how software applications can efficiently improve knowledge sharing during an Operational Planning Team (OPT) session. Having this context provides a platform for increased operational awareness of how real time information empowers the commander, staffs, and planners. Finding indicates that the PAE, a layer seven software extension, can be highly effective if properly leveraged by staffs and planners. Conversely, PAE is not well known and has a complex graphical user interface (GUI). Both attributes greatly affected the adoption rate of this platform. Thesis recommendations are that PAE become software of record to provide continuity in the execution of Marine Corps Planning Process (MCPP) regardless of geographic location. MAGTF staff training program (MSTP) should incorporate PAE in future MAGTF training, both integrated into the current curriculum and through distance learning. Furthermore, an updated PAE GUI will provide an intuitive experience and influence the perceived ease of use (PEOU) for the user.

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AUTOMATION OF THE MARINE CORPS PLANNING PROCESS

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ABSTRACT

In today's world, innovations in software have provided organizations a platform to establish a collaborative environment that leverages new technologies. The Marine Corps is not immune from this innovation and must look at current innovations that can link current systems to decision makers. As today's technology has advanced, the Marine Corps' duty is to influence innovation to provide a collaborate environment. This collaborative environment, specifically command and control (C2) systems, must facilitate information retrieval at all levels while maintaining the authoritative integrity. This thesis provides information about Planning Application Extension (PAE), a collaborative software currently employed within Marine Air Ground Task Force (MAGTF). Furthermore, this thesis examines how software applications can efficiently improve knowledge sharing during an Operational Planning Team (OPT) session. Having this context provides a platform for increased operational awareness of how real time information empowers the commander, staffs, and planners. Finding indicates that the PAE, a layer seven software extension, can be highly effective if properly leveraged by staffs and planners. Conversely, PAE is not well known and has a complex graphical user interface (GUI). Both attributes greatly affected the adoption rate of this platform. Thesis recommendations are that PAE become software of record to provide continuity in the execution of Marine Corps Planning Process (MCPP) regardless of geographic location. MAGTF staff training program (MSTP) should incorporate PAE in future MAGTF training, both integrated into the current curriculum and through distance learning. Furthermore, an updated PAE GUI will provide an intuitive experience and influence the perceived ease of use (PEOU) for the user.

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LIST OF ACRONYMS AND ABBREVIATIONS

AA	air assault
ACE	aviation combat element
ADA	air defense
AI	artificial intelligence
AI	air interdiction
AO	area of operations
AS	area support
AS	air strike
ASR	alternate supply routes
BDAR	battle damage assessment and repair
BI	behavioral intention
BPR	business process reengineering
C2	command and control
C2PC	command and control personal computer
C4ISR	command, control, communications, computers, and systems for intelligence, surveillance, and reconnaissance
CASCOM	Combined Arms Support Command
CAT	crisis action team
CCIR	commander's critical information requirements
CGSC	Command and General Staff College
CIDNE	Combined Information Data Network Exchange
CMOB	Career Management Operations Branch
COA	course of action
COC	combat operations center
COFM	correlation of forces matrix
COG	center of gravity
COIN	counterinsurgency operations
CONOP	concept of operations
COP	common operating picture
COP/CTP	common operational picture/common tactical picture
CP	check point
CSS	combat service support
CTP	common tactical picture
DIME	diplomatic, informational, military and/or economic
DOD	Department of Defense
DS	direct support

ECM   Expectancy Continuance Model
EOU   ease of use
EPLRS   Enhanced Position Location and Reporting System
ESGPP   ESG Planning Process

FA   field artillery
FRAGO   fragmentary order

GCE   ground command element
GS   general support
GUI   graphical user interface

HHQ   higher headquarters

IOW   intelligence operations workstation
IT   information technology

JMEMS   Joint Munitions Effectiveness Manuals
JTCW   joint tactical common operating picture workstation

KVA   knowledge value added

LF   landing field
LIN   line item number
LZ   landing zone

MAGTF   Marine Air Ground Task Force
MBA   main battle area
MCDP   Marine Corps Doctrinal Publication
MCPP   Marine Corps Planning Process
MEDCOM   Medical Command
MEU   Marine Expeditionary Unit
MEU/ARG PP   MEU/ARG Planning Process
MOB   main operating base
MPC   mission planning cell
MRE   meals ready to eat
MSR   major supply routes
MSTP   MAGTF staff training program

NSN   national stock number

OPLAN   operations plan
OPORD   operations order
OPT   Operational Planning Team

PAE	Planning Application Extension
PDE&A	planning, decision, execution, and assessment
PEOU	perceived ease of use
PMESII	PAE diplomatic, information, military, and economic
PU	perceived usefulness
PZ	pickup zones
R&S	reconnaissance and surveillance
R2P2	Rapid Response Planning Process
RCP	relative combat power
ROK	return on knowledge
RP	release point
SA	situational awareness
SIGACTS	significant actions
SOP	standard operating procedures
SP	starting point
TAM	Technology Acceptance Model
TAMCN	table of allowance material control number
TaskOrg	task organization
TFSMS	Total Force Structure Management System
TTPs	tactics, techniques, and procedures
WARNORD	warning order

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EXECUTIVE SUMMARY

In today's world, innovations in software have provided organizations a platform to establish a collaborative environment that leverages new technologies for operational planning. The Marine Corps should take advantage of this emerging environment and look at existing technological capabilities that can leverage current systems to support decision makers. As today's technology has advanced, the Marine Corps should leverage technical innovation that will provide a more productive collaborate environment. This collaborative environment, specifically command and control (C2) systems, must facilitate information retrieval at all levels while maintaining an authoritative integrity.

This thesis provides a review of capabilities of collaborative software currently employed within Marine Air Ground Task Force (MAGTF). Furthermore, this thesis examines how software applications can efficiently improve knowledge sharing during an Operational Planning Team (OPT) session. Having this context provides a platform for increased operational awareness of how real time information empowers the commander, staffs, and planners.

The thesis findings indicated that the Planning Application Extension (PAE), a layer seven software extension, could be highly effective if properly leveraged by staffs and planners. PAE provides a powerful platform for wargaming by leveraging artificial intelligence (AI). The AI within PAE is a complex computation of algorithms that enable multiple courses of action (COAs) to be analyzed and simulated with regards to enemy against friendly relative combat power (RCP). Furthermore, PAE empowers commanders to simulate each COA and provide immediate feedback to subordinates while enabling a highly responsive staff action, which allows staff and planners to make real time changes to the plan regardless of geographic location.

Finally, PAE has shown several potential benefits as a result of a knowledge value added (KVA) simulation. By using Rapid Response Planning Process (R2P2) as a sample base for the KVA simulation, PAE enabled a 50% reduction in staffing of a standard Marine Expeditionary Unit (MEU) planning teams, which allowed a cost reduction of

39% per planning process session. Additionally, PAE enabled the standard six hours R2P2 process to be reduced to four hours and 44 minutes, a savings of one hour a 16 minutes. However, PAE is not well known and has a complex Graphical User Interface (GUI). Both attributes greatly affected the adoption rate of this platform.

Thesis recommendations are that PAE is a software of record and that MAFTF Staff Training Program (MSTP) conduct studies focused on time savings analysis, the benefits of distance learning for C2 systems, and on bandwidth analysis of PAE during OPT planning sessions. Furthermore, MSTP should incorporate PAE in future MAGTF training for both residential and distance learning programs. Additionally, an updated PAE GUI will provide an intuitive experience and influence the perceived ease of use (PEOU) for the user.

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I. INTRODUCTION

A. PROBLEM OVERVIEW

In today's world, innovations in software have provided organizations a platform to establish a collaborative environment that leverages new technologies. The Marine Corps should look at existing collaborative technologies that can link current systems to decision makers. The problem is the Marine Corps Planning Process (MCPP), which provides the commanders, and their staffs, a means to organize their planning activities and transmit the plan to subordinates' commanders, is not standardized. This situation is a problem because current software within the Marine Corps is not being leveraged to mitigate the inconsistent information that inhibits or disrupts the commanders' decision-making process. A potential solution is the use of Planning Application Extension (PAE). Furthermore, by leveraging PAE, the Marine Corps should be able to reduce time and cost during an operational planning session. A second problem is PAE is not being widely used, which creates an adoption rate problem.

The purpose of this thesis is to gain insights into the potential benefits and challenges the Marine Corps has in adopting PAE and using it during Operational Planning Team (OPT) sessions. This thesis specifically uses the case of the Rapid Response Planning Process (R2P2) to frame an understanding of how adopting PAE will contribute to R2P2 effectiveness. This study tests two approaches (i.e., manual or automated) to R2P2, and controls for planning sessions and time. The manual process of R2P2 serves as a baseline "as-is" of the planning process. It provides measures by which the incorporation of information technology (IT) systems and software can be evaluated. In this research, the knowledge value added (KVA) methodology is used to compare the "as-is" process to the "to-be" processes in which notional IT systems and software are incorporated. The results of these comparisons are provided to the Marine Corps as recommendations regarding the development of IT systems to aid the planning process.

This information is vital because as today's collaborative technology has advanced, the Marine Corps has an opportunity to leverage existing innovation like PAE

that will provide a more robust collaborate environment. This collaborative environment, specifically command and control (C2) systems, must facilitate information retrieval at all levels while maintaining an authoritative integrity. The Department of Defense (DOD), and specifically the Marine Corps, has seen a significant increase in technology that links mission planning to decision makers. As the technology and its influence on mission planning continue to expand, planners must define what information will be the most useful in planning future operations. Many of the fundamental principles of collaboration are embedded in Marine Corps doctrine, publications, and pamphlets that comprise a structured manual process for decision making.

Currently, a variety of recent studies on collaborative planning by McKearney (2013), Rogers (2011), and McKenna (2006) illustrate the use of collaborative tools in military planning that influence decision making. These studies provide a foundation in a collaborative environment for an OPT through automation and help identifying the information requirements a commander needs in making a decisive decision during combat operations. Furthermore, through the use of the Davis's (1989) Technology Acceptance Model (TAM) a framework of how information influences users' perceptions and perceived ease of use (PEOU) can potentially impact the adoption rate of PAE.

B.   OBJECTIVE

The current thesis research provides awareness of collaborative tools currently employed within Marine Air Ground Task Force (MAGTF). A MAGTF is an air-ground force task organized structure to meet specific mission, which falls under a single commander (MCDP 1-0, 2001). Additionally, this thesis examines how PAE can efficiently improve knowledge sharing during an OPT session, as well as illustrate the adoption rate challenges the Marine Corps may have towards PAE. PAE is a layer seven software components designed to assist planners in all aspects of planning and used in the next generation C2 system, the joint tactical common operating picture workstation (JTCW). PAE frees staffs and planners from most of the mundane tasks like course of action (COA) development and order development, which is associated with operational

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planning. PAE allows staffs to focus on the higher-level concepts: missions, plans, tasks, activities, and resources.

This thesis was designed to collect data to address the following research questions.

- Does automation exist that will enhance collaboration during MCPP?
- How will PAE software design enhance capabilities within the OPT?
- How does PAE enhance collaboration?
- How much value does PAE add to R2P2?

C. METHODOLOGY

Initial research is primarily secondary research focused on gathering information from books, periodicals, knowledge bases, and other library information services describing collaborative technology. Additionally, research is conducted through a review of the decision-making process and the decision cycle used within the Marine Corps. Secondary research also includes an analysis of collaborative tools currently used within the MAGTF to assess the contribution they have made and address the challenges in their adoption.

Finally, this thesis models R2P2 as conducted during a simulation and establishes the baseline analysis of the planning process using the KVA methodology. In conducting the KVA analysis, the Return on Knowledge (ROK) for each of the planning processes as a whole is determined. As the ROK baseline is established, a hypothetical scenario with notional software technologies—specifically PAE—is evaluated to determine the impact of the IT systems within R2P2.

D. THESIS ORGANIZATION

This thesis comprises five chapters. The first chapter provided the problem statement overview, objective, and methodology employed to conduct the research on MCPP automation. Chapter II presents an introduction to TAM while providing background and elements that shape a commander's decision cycle and behavioral intension. Chapter III continues to address technology acceptance while focusing on current C2 within an MAGTF. Chapter IV provides a look at disruptive technologies

while outlining the capabilities of PAE, which has been developed to link MCPP and MAGTF C2 systems. Chapter V reviews the findings from the case study and provides conclusions and recommendations for future collaborative work.

II. BACKGROUND

> Planning is the art and science of envisioning a desired future and laying out effective ways of bringing it about.
>
> —MCDP 5, *Planning*

A. INTRODUCTION

Through the TAM, this chapter illustrates a user's behavioral intention (BI) towards the use PAE. As seen in Figure 1, the user's BI towards the use of the system is influenced by the perceived usefulness (PU) and perceived ease of use (EOU) of that system (Davis, 1998). This study uses TAM as a framework to analyze Marine Corps Doctrinal Publication (MCDP) 1, MCDP 5, and MCDP 1-0. These documents provide an introduction into methodologies of fighting a war and establish a basis for the ways Marines interprets how to fight a war. As seen in MCDP 1, Marines are introduced to three levels of warfighting: strategic, operational, and tactical, which provides background in understanding requirements for new software application while establishing a foundation for BI in using that new software application. As Davis (1998) noted, if users can be influenced by a system they are using that is of high quality, their actual system use will increase.
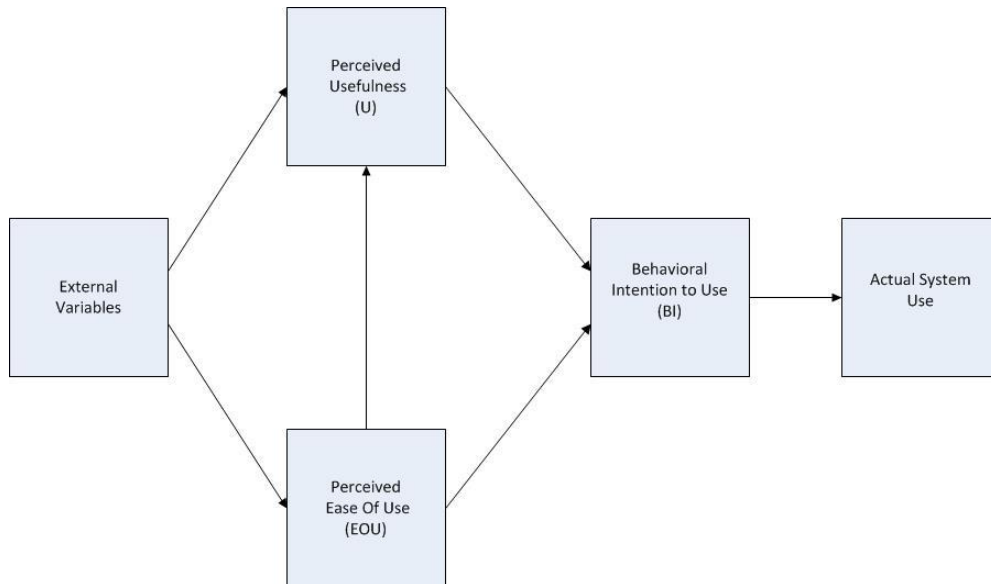
Figure 1.   Technology Acceptance Model (TAM) (from Davis, 1998)

This finding is significant because Naveh (1997) noted the operational level of war concept was not seen in military doctrine until the 1970s. Naveh goes on to state that military forces have steadily sought improvements to operational interpretations, methodology, and resources that link the strategic and tactical phases of armed conflict. Over time, this understanding has forced definitions of operational level of war to mature (Naveh, 1997). Since TAM suggests that users' BI be facilitated by their belief in the PU and PEOU of the system, changing their perceptions about that system would influence their use of that system that, in turn, would increase the adoption of the system. This perception is a substantial paradigm, which requires a closer look at how the Marine Corps should leverage PAE to continue the growth in operational interpretations, methodology, and resources.

As Marines conclude 10 years of combat in Afghanistan and Iraq, the links between all three levels of war have been solidified and accepted by them. Both operational art and design provide a starting point that begins to build the operational structure (JP 3-0, 2010). As illustrated in MCWP 3-40.1 (2010) the planning, decision, execution, and assessment (PDE&A) cycle is the process commanders and their staff use to plan operations, make accurate and timely decisions, direct the effective execution of operations, and assess the results of those operations. Through the use of PAE, linking this mental picture (operational structure), leaders will have an increased awareness that encompasses all activities occurring within the operational level of war and translating strategic guidance into cohesive tactical actions.

B.   DESIGN THEORY

A seen in Figure 2, a distinct difference exists between design and planning. The design and planning continuum model allow planners to understand the nuances between design and planning while illustrating how both activities seek to formulate ways to bring desired outcomes. Requirements are easily developed out of the design and planning continuum model and provide a blueprint on the perception that PAE could have on the BI of a user. As noted in MCDP 5, planning uses two basic functions, envisioning desired outcome, and arranging a structure of potential action in time and space that allows a

desired endstate. As noted in MCDP 1-0, planning can be placed in three levels: conceptual, functional, and detailed. These three levels of planning provide a focus on generating a plan while allowing planners to focus on the design of learning about the nature of the problem. As seen in PAE, a planning checklist tool allows the user to display the different planning processes like MCPP, MEU/ARG Planning Process (MEU/ARG PP), Army Planning Process (the MDMP) and the ESG Planning Process (ESGPP) (PAE Manual, 2013). These checklists provide a starting point for functionality of PAE and the first step toward the BI of the user when designing an operations plan.
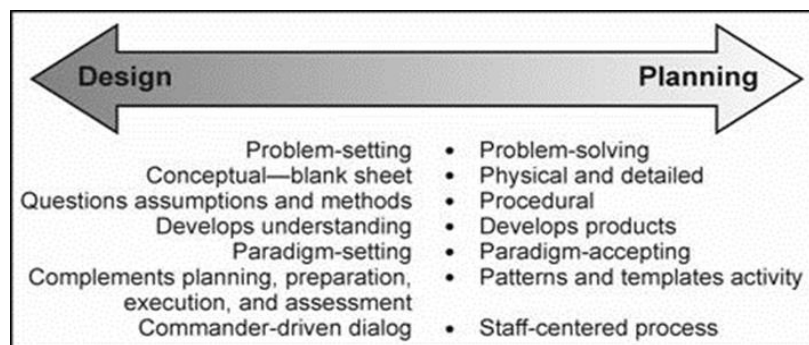
Figure 2.   Design and Planning Continuum

Maier and Rechtin (2002) define design as embodying architecting that deals mostly with unmeasurable using non-quantitative tools and guidelines based on practical lessons learned. Design analyzes the nature of the problem and provides a framework for solving that problem. By using Maier and Rechtin' (2002) understanding of design, an outline is established for software to enhance operational planning resulting in detailed military orders and tactical action. An example is PAEs Operational Plan (OPLAN) function, which provides the user with specific information regarding mission. OPLAN provides subordinates with the operational and tactical freedom to accomplish the mission.

PAE can assist commanders in developing a conceptual framework within an organization to understand, visualize, and illustrate the operational environment. Since the environment is dynamic, problems also evolve. An example is commanders conceptualize their operation; their periodic guidance is in the form of visualization,

description, and direction, which guides the staffs throughout the planning. Through an understanding of design, said commanders have the means to learn and critically think while actively engaging decision making at all levels. Design as defined by Maier and Rechtin (2002) provides a starting point for Marine Corps planning theory.

C. MARINE CORPS PLANNING THEORY

Marine Corps planning theory is a fundamental understanding of warfighting concepts and planning references MCDP 1, MCDP 5, and MCDP 1–0 illustrate a building block approach to explain the Marine Corps' requirements in both manual and automated processes. MCDP 1 provides guidance on warfighting concepts pertinent to planning. MCDP 5 analyzes the Marine Corps planning theory. Finally, this thesis clarifies how Marine Corps planning theory influenced and shaped operational planning concepts in MCDP 1–0. Furthermore, by establishing a lens using TAM, an understanding would develop of how PAE can affect perceived useful and ease of technology.

1. MCDP 1 Warfighting

MCDP 1 establishes the Marine Corps philosophy on war, and within this philosophy, three factors influence Marine Corps planning theory (MCDP 1, 1997): the complexity of war, the science/art of war, and the centrality of the commander. The complexities help elevate the importance of using automation. MCDP 1 describes war as a "complex phenomenon" (p.12, para. 2) and continues to explain, "as a result, war is not governed by the actions or decisions of a single person in any one place but emerges from the collective behavior of all the different parts in the system interacting locally in response to local conditions and incomplete information" (MCDP 1, 1997, p. 12. para. 3). MCDP 1 goes on to illustrate, "conduct of war is fundamentally a dynamic process of human competition requiring both the knowledge of science and creativity of art, but driven ultimately by the power of human will" (MCDP 1, 1997, p.19, para. 1).

In response to this concept, planning theory must cope with the art and science elements associated with conducting and planning warfare. A balance between artistic elements, such as creative solutions resulting from an awareness of the situation, and the

science elements, such as planning to support limited transportation assets, is a delicate balance. Planning processes and theory must provide mechanisms for operational architecting (artistic elements), operational planning (scientific elements), and their interaction. As seen when PAE allows users to share plans with other users running the planning, application in a military operation. Finally, MCDP 1 describes the centrality of the commander to all warfighting activities (MCDP 1, 1997).

The commander is central to the organization structure, planning, and action. Therefore, a USMC planning theory must describe this commander's lead role in all planning activities. In summary, for Marine Corps planning theory to be consistent with Marine Corps warfighting philosophy, Marine Corps planning theory must cope with war as a complex system as seen in both Iraq and Afghanistan. Marine Corps planning theory must also apply both art and science to the planning and execution of warfare through the use of existing software like PAE that will enable the commander to become the central participant in planning. This concept falls in line with one element of TAM, that a perception of technology is perceived useful, and starts to fill in the values of increasing productivity and making jobs easier (Segars & Grover, 1993).

2. MCDP 5 Planning

MCDP 5 explains that the "publication describes the theory and philosophy of military planning as practiced by the U.S. Marine Corps" (MCDP 5, 1997, page 2, para. 1). MCDP 5 consists of three chapters. Chapter I defines planning and plans, as well as a general characteristic of the process. Chapter III presents characteristics of good plans and the relationship between the commander and planners. This thesis focuses on Chapter II, as it presents the theory behind the Marine Corps planning process.

The analysis of MCDP 5 provides elements of the Marine Corps planning theories, which are the classical decision-making process, analysis, and synthesis, the centrality of the commander and a tactical focus (MCDP 5, 1997). A seen in Figure 3, the classical decision-making process set the foundation for the Marine Corps' planning theory and develops a framework for automation.
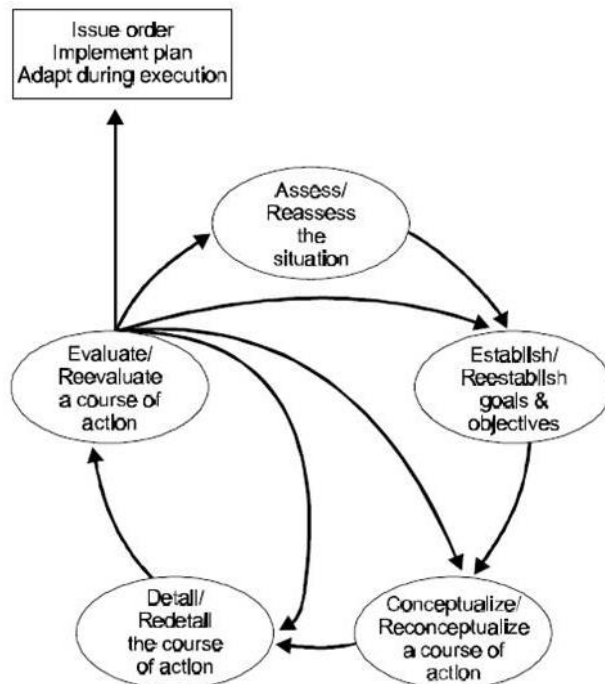
Figure 3. Presents the Classical Decision Making Process
(from MCDP 5, 1997)

This process is used to manage both analysis and synthesis activities. MCDP 5 defines analysis as "the systematic process of studying the subject by successively is decomposing the subject into parts and dealing with each of the parts in turn" (p. 34, para. 1) and synthesis as the "creative process of integrating elements into a cohesive whole." (p. 34, para. 2) Therefore, MCDP 5 describes the science of war as analysis and the art of war as synthesis. To illustrate, these current C2 systems provide a link that helps staffs to analyze information that then is synthesized into segments of information that help the commander make a decision. MCDP 5 relates these concepts to actual activities mapped as the hierarchy of planning, consisting of the conceptual, functional, and detailed levels. Conceptual planning is the highest level of planning primarily requiring synthesis activities while detailed planning is at the bottom of the hierarchy, primarily requiring analysis activities. Functional planning is the middle level requiring elements of art and science. According to Marine Corps planning theory, the higher levels of the planning hierarchy require more synthesis, whereas lower levels need more analysis (MCDP 5, 1997) as shown in Figure 4.

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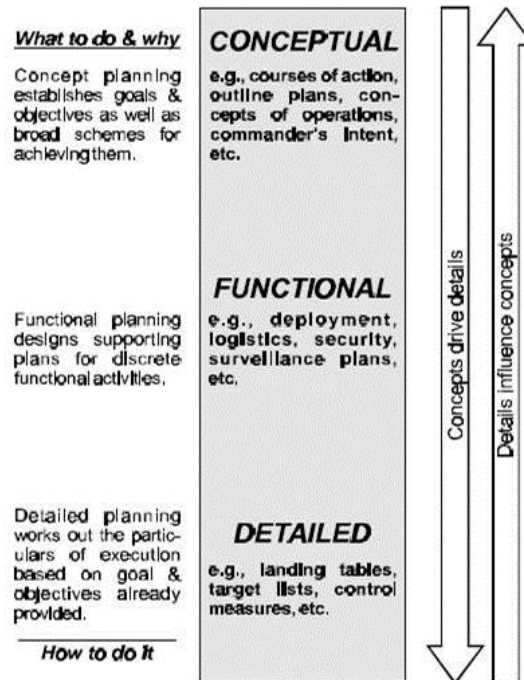
Figure 4.   Presents the Marine Corps Planning Hierarchy
(from MCDP 5, 1997)

Central to the planning hierarchy and the application of art and science are the roles of a commander. Marine Corps planning theory centers on the commander who is primarily responsible for conceptual planning while functional and detailed planning activities are delegated to the staffs (MCDP 5, 1997). An example is receiving an order from higher headquarters (HHQ). The commanders will provide an intent or expectation (art of war) of how to achieve HHQ mission while the staffs will focus on how to execute (science of war), which is the commander's intent. PAE takes this one step further and provides planners with an auto wargaming function that provides them with a rough COA to ascertain if the COA is viable. Auto wargaming is a great example of how PAE can influence the users' PEOU.

3.   MCDP 1–0 Marine Corps Operations

MCDP 1–0 (2001) "represents how warfighting philosophy is classified in operational terms" and "is the transition-the bridge-between the Marine Corps' warfighting philosophy of maneuver warfare to the tactics, techniques, and procedures

(TTP) used by Marines" (MCDP 1–0, 2001, page 2, para. 2). For the Marine Corps, MCDP 1–0 is part theory and part operational. It is important to analyze this thesis as it relates to the planning theory presented in MCDP 1 and 5 and the planning process presented in MCWP 5–1. Specifically, focusing on how existing technology can enhance Marine Corps operations, such as PAEs, which is based on Marine Corps doctrine to provide consistency in information (Savinovich, 2013).

MCDP 1–0 (2001) translates planning theory into more operational specifics by categorizing the central role of the commander and summarizing the planning hierarchy. According to Naveh (1997), operational level planning bridges the concept of strategy and the mechanical act of tactics. MCDP 1–0 follows suit with MCDP 5 and delegates most of the conceptual planning and the artistic elements of war to the commanders. It is organized in what MCDP 1–0 (2001) describes as the operational design. MCDP 1–0 defines operational design as "the commander's tool for translating the operational requirements of his superiors into the tactical guidance needed by his subordinate commanders and staff" (p. 6-3, para. 3). The commanders use their operational design to visualize, describe, and direct those actions necessary while building the behavior needed to achieve the mission that is in line with TAMs' value of working more quickly.

The operational design includes "the purpose of the operation, what the commander wants to achieve, the desired effects on the enemy, and how he envisions achieving a decision" (MCDP 1–0, 2001, p. 6-3, para. 3). In essence, MCDP 1–0 requires the commander to apply the art of war to understand the environment, situation, and conceptual solution alone without staff assistance. MCDP 1–0 describes the commanders as lone conceptual planners with the details left for the staffs. In practice, commanders do not perform all conceptual planning alone, and most likely, the commanders' staffs are involved from the beginning. However, if the Marine Corps followed its doctrine closely, the commander would essentially frame the environment, situation, and conceptual solution almost entirely alone. By leveraging PAE ability to import/export through multiple systems, an increase in the commanders' operational reach would be achieved while again building on technology acceptance as defined by Bhattacherjee (2001) that notes that technology is better understood with continued use.

4. Summary

Marine Corps planning theory focuses on the classical decision model, the role of the commander, and execution of the art and science of warfare during planning. Marine Corps planning theory also builds on behavioral intention by allowing commanders freedom within a planning framework to mature their attitude toward adoption of technology. Through the use of PAE, the commanders allow their staffs more time to focus on the art of warfighting, which provides a preconception of usefulness as defined by Davis (1989), the degree to which a person believes that using a particular system would enhance his or her job performance. Analyzing the use of PAE in gathering information using TAM provides a stepping stone towards technology acceptance. Moreover, the remainder of this chapter refers to the Marine Corps Warfighting Publication (MCWP) 5-1, which will lay the groundwork for tenets that will frame the requirements for PAE while illustrating elements of MCPP that link theory and execution.

D. TENETS OF THE PLANNING PROCESS

MCWP 5-1 identifies three tenets of the MCPP: top-down planning, a single battle, and integrated planning. These tenets are derived from the doctrine of maneuver warfare. Maneuver warfare is defined as a warfighting philosophy that focused on breaking the enemy's unity through a diverse act of rapid, fixated, and unpredicted activities, which create a tempestuous and swift weakening enemy will to fight (MCDP 1–0, 2001). Tenets guide the commanders' use of their staffs to plan and execute military operations (MCWP 5-1, 2010). Top-down planning and the single-battle concept ensure unity of command, that is to say, unity of effort while, the commanders use the OPT to ensure integration of the warfighting functions across the staffs and subordinate and supporting units.

1. Top-Down Planning

Planning is a fundamental responsibility of command, and commanders must actively participate in directing the planning process (MCWP 5-1, 2010). The commanders' intent and guidance are essential to planning and establishes the first step in

gaining knowledge and understanding supporting their decision-making process. Their plan, communicated in oral, graphic, or written format, translates their guidance into a plan of action for their subordinate commanders. As seen, PAE interface capabilities allow users to share plans with other users running the planning application (PAE Manual, 2014). Top-down planning is a building block for a single-battle concept.

2. Single-Battle Concept

Single battle is a unifying perspective that recognizes the interrelationship among dispersed actions. For example, the success of deep fires facilitates rapid ground maneuver. Commanders' intent can only set conditions for a single battle concept that both guides and empowers subordinates to act towards unforeseen conditions within the framework of a larger design. Commanders realize a single battle in execution through the willing cooperation of subordinates to understand their role and coordinate laterally while exercising top sight (a grasp of the larger picture). The battlespace is conceptually divided into deep, close, and rear areas, which assist in decentralized execution and planning. Commanders' intent ensures unity of effort by fighting a single battle (MCWP 5-1, 2010). The planning application allows commander to define tasks and see the effect of those tasks over a period of time. This animation within PAE provides validation to the single battle concept and confirms the efforts of all the elements of force to accomplish its assigned mission (PAE Manual, 2014). An example is once the single-battle concept is accomplished, the staffs will integrate the commanders' intent, and by leveraging technology, can link the needed resources to enhance the overall operational plan that will increase the adoption rate of PAE.

3. Integrated Planning

Integrated planning provides the commanders and their staffs a disciplined approach to planning that is systematic, coordinated, and thorough (MCWP 5-1, 2010). Through the OPT, it incorporates expertise from all the warfighting functions—command and control, maneuver, fires, intelligence, logistics, and force protection to provide unity. Unity of effort is gained through integrated planning, which allows planners to consider all relevant factors and develop a link to subordinate actions. By providing integrated

planning, PAE provides a platform that can influence the connection of resources and ideas to allow staffs more time to use their military experience when validating the overall operational plan. As seen using PAEs' auto wargaming allows commanders to determine an asset required by two or more units and then task organize by time (PAE Manual, 2014).

E. WARFIGHTING FUNCTIONS

Marine Corps warfighting functions encompass all military activities in the battlespace that allows planners to integrate the warfighting functions when designing how to achieve the mission. Integrating the warfighting functions ensures an integrated plan and helps achieve unity of effort and focus. As stated in MCDP 1-2 (2012), campaigning, and Marine forces obtain "maximum impact by harmonizing the warfighting functions to achieve the desired objective within the shortest time possible and with minimum casualties." (p. 76, para. 1) The six warfighting functions are command and control, maneuver, fires, intelligence, logistics, and force protection. They apply equally across the range of military operations and are the building blocks for all types of operations, including prolonged, amphibious, distributed, information, and counterinsurgency operations (COIN). Each warfighting function is detailed as follows and delivers a blueprint for software design that can enhance operational reach of the combatant commander.

1. Command and Control

As stated in MCWP 5-1 (2010), by having authority and direction over attached or assigned forces, commanders display command and control. Command and control enable commanders to convey their intent and decisions in concert with receiving feedback (MCWP 5-1, 2010). Command and control involve "arranging personnel, equipment, and facilities to allow the commander to extend his influence over the force during the planning and conduct of military operations" (MCWP 5-1, 2010, Appendix B, para. 3). Command and control provides a balance between the art and science of Marine Corps theory.

2.   Maneuver

In JP 1-02 (2012), Department of Defense Dictionary of Military and Associated Terms, the DOD defines maneuver as "the employment of forces in the operational area through movement in combination with fires to achieve a position of advantage in respect to the enemy in order to accomplish the mission." (p. 163, para. 9) Maneuver allows for distribution or concentration of capabilities in support of the commander's concept of operation (CONOP). The Marine Corps maneuver warfare philosophy expands the concept of maneuver to include taking action in any dimension, whether temporal, psychological, or technological, to gain an advantage. In COIN operations, for example, forces may achieve advantages through key leader engagements, provision of security, governance, economics, and the rule of law. PAE provides commanders the ability to task multiple users either one-to-one relationship, or a one to many/many to many/many to one relationship and graphically watch the unit's maneuver using the execution matrix automation.

3.   Fires

In JP 1-02 (2010), the DOD defines fires "as the use of weapon systems to create a specific lethal or non- lethal effect on the target." (p. 96, para. 9)Fires harass, suppress, neutralize, or destroy accomplish the targeting objective, which may be to disrupt, delay, limit persuade, or influence. Fires include the collective and coordinated use of target acquisition systems, direct and indirect fire weapons, and other lethal and nonlethal means (MCWP 5-1, 2010). Fires are traditionally used in concert with maneuver (combined arms), which helps shape the battlespace, setting conditions for decisive action. As seen in PAE, using the surface-to-surface fires function lets commanders provide covering fire against enemy units while visually tracking units on the map (PAE Manual, 2014).

4.   Intelligence

Intelligence enables the commander to gain an understanding of the adversary, operational environment, and identifies the adversary's center of gravity (COG) and critical vulnerabilities (MCWP 5-1, 2010). It aids the commanders and staffs in problem

framing, alerts them to new opportunities, and helps assess the effects of actions within the battlespace. An example in PAEs is the significant actions (SigActs) feature, which allows the user to view significant actions with user-defined filters and correlating these actions to various calendars to help model predictions for future actions within an event type (PAE Manual, 2014). This warfighting function supports and integrates the overall operational effort, and must focus on the commander's intelligence requirements (MCWP 5-1, 2010).

5. Logistics

As noted in MCWP 5-1 (2010), logistics comprises all activities needed to move and sustain military forces. At the tactical level, logistics is combat service support (CSS) that deals with feeding, fueling, arming, and maintaining troops and supplies (MCWP 5-1, 2010). Logistic functions like supply, maintenance, transportation, and other services define tactical logistics (MCWP 5-1, 2010). PAE provides a robust suite of software extensions that enable users to plan both at a high level (theater level) for general logistical requirements and at a low level (battalion or company) to assist the logistician at the tactical level (PAE Manual, 2014).

6. Force Protection

Force protection is the measures taken to preserve the force's combat capability, which allows the commander to apply at a specific time and place (MCWP 5-1, 2010). Force protection is those measures the force takes to remain combat capable. Force protection safeguards friendly COG and protects, conceals, reduces, or eliminates friendly critical vulnerabilities.

F. MARINE CORPS PLANNING PROCESS

The MCPP is a process that allows staffs to link the Marine Corps warfighting philosophy (MCWP 5-1, 2010). By leveraging PAE, MCPP becomes not only linked to the theory, but to C2 systems within the Marine Corps. MCPP is designed for the commander to take on a central role as a decision maker and provides a systematic process that organizes the thoughts of the commanders and their staffs. The intuitive

process of MCPP applies to all levels of command and staff actions (MCWP 5-1, 2010). As noted in MSTP Pamphlet 5-0.2, both commanders and staffs who have longer planning horizons and access to more information, will lean toward using the formal and comprehensive approach to the MCPP. Having commanders and staffs lean toward using the formal and comprehensive approach to the MCPP falls in line with TAM and provides a good metric to establish validate PAEs PEOU and PU.

Conversely, commanders and staffs with less information and shorter planning horizons will be able to scale/modify the MCPP process to meet their objective/task (MCWP 5-1, 2010). Again, a great illustration of PAE scalability is provided as seen when commanders use the expeditionary operations planning function, which allows the user the ability to plan amphibious, heliborne, or air assault operations inside an overall tactical plan (PAE Manual, 2014). Additionally, MCPP provides a platform to develop planning activities and transmit the plan to subordinates for the commanders and their staffs (MSTP Pamphlet 5-0.2 2012).

As illustrated in MCWP 5-1, by using MCPP, multiple levels of command can concurrently plan, while having a general understanding of the mission and commanders' intent. MCPP develops a systematic procedure for analyzing a problem, developing and wargaming COAs against that problem, equating friendly COAs against the commanders' criteria and each other, selecting a COA, and preparing an operation order for execution (MCWP 5-1, 2010). As shown in MSTP Pamphlet 5-0.2 (2012), MCPP organizes the planning process into six coherent steps as shown in Figure 5 (MSTP, 2012).

An analysis of these six steps and how they are automated through the use of PAE will exemplify the values (increasing productivity, making the job easier, usefulness, effectiveness, overall job performance, and working more quickly) associated with PU (Segars & Grover, 1993).
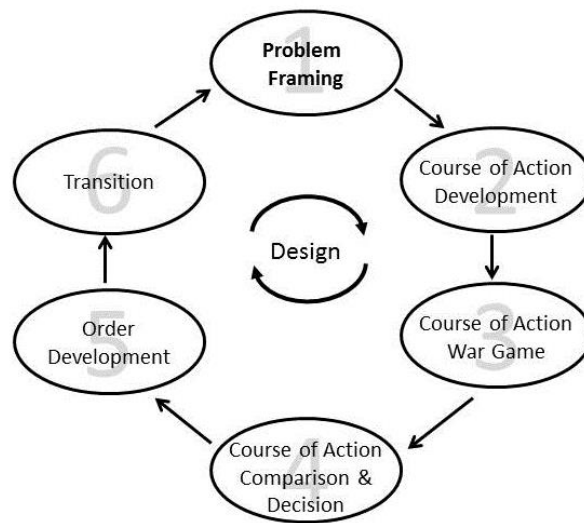
Figure 5.   Marine Corps Planning Process (from MSTP, 2012)

1.   Problem Framing

As noted in MCWP 5-1 (2010), the purpose of problem framing is to enhance understanding of the environment and the nature of the problem. Problem framing allows commanders and staffs to articulate what, when, and why a unit must accomplish a mission or task (MCWP 5-1). MCWP 5-1 continues to state problem framing may begin as an informal response to indications and warnings, or more formally, when an order or directive (including the HHQ mission and tasks to subordinate commands) is received. Design does not end with problem framing because the situation constantly evolves and requires the commanders to review, and possibly modify, their design (MSTP Pamphlet 5-0.2 2012). As seen in Figure 6, injects are gathered during problem framing to allow the commanders and staffs to continue activities that will develop results for both HHQ and subordinate commands. PAE provides a collaborative environment with other systems that provide information gathering that help commanders and staffs problem frame. As seen using PAE's planning assistant, which provides a collaborative environment that allows changes to be made to the checklist and posting documents to an accessible location, allows them to be shared by other users in the chain of command (PAE Manual, 2014). PAE's planning assistant provides a link with Segars and Grover's (1993) concept of values associated with PU.
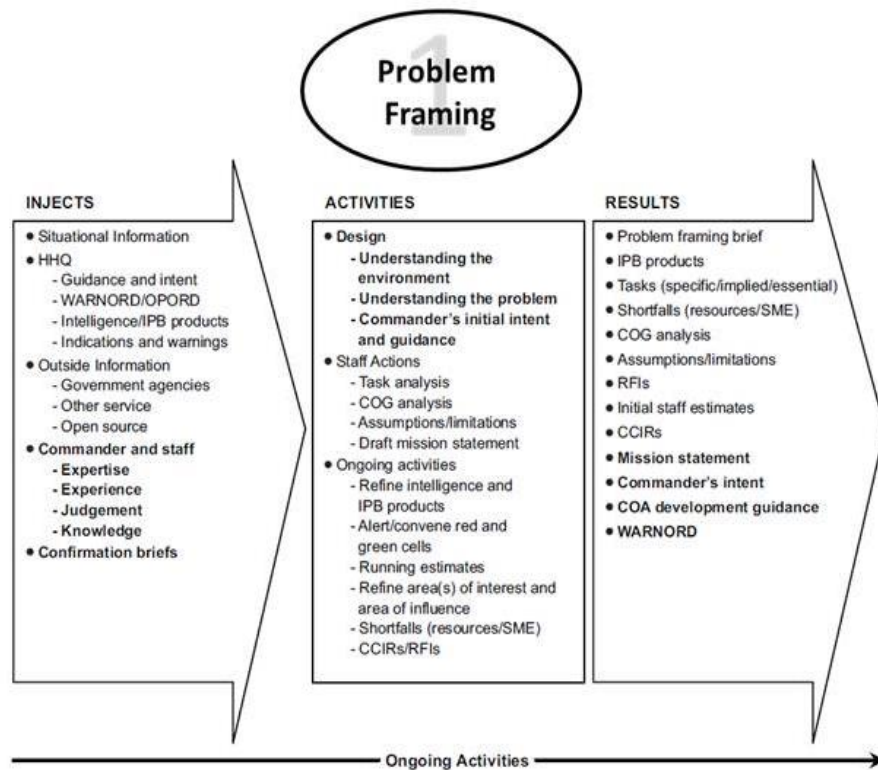
Figure 6.   Problem Framing (from MSTP, 2012)

2.   Course of Action Development

As noted in MCWP 5-1 (2010), COA development allows staffs and planners to develop multiple options that allow the unit to complete the mission and the commanders' intent. Design helps to inform the commanders' intent and guidance, and provides options for the commanders while continuing to refine the understanding of the environment and problem (MSTP Pamphlet 5-0.2 2012). To be distinguishable, each COA must employ different means or methods that address the essential tasks while incorporating the commanders' intent and guidance. As seen in Figure 7, planners use the products carried forward from problem framing to generate options or COAs that satisfy the mission in accordance with the commanders' intent and guidance. PAE provides several interfaces that allow commanders and staffs to develop COAs. An example is PAE's GUI, which facilities COA development by allowing planners to use individual menus, click specific buttons on the toolbars, or use right-click options to create tasks.

Course of Action Development
2

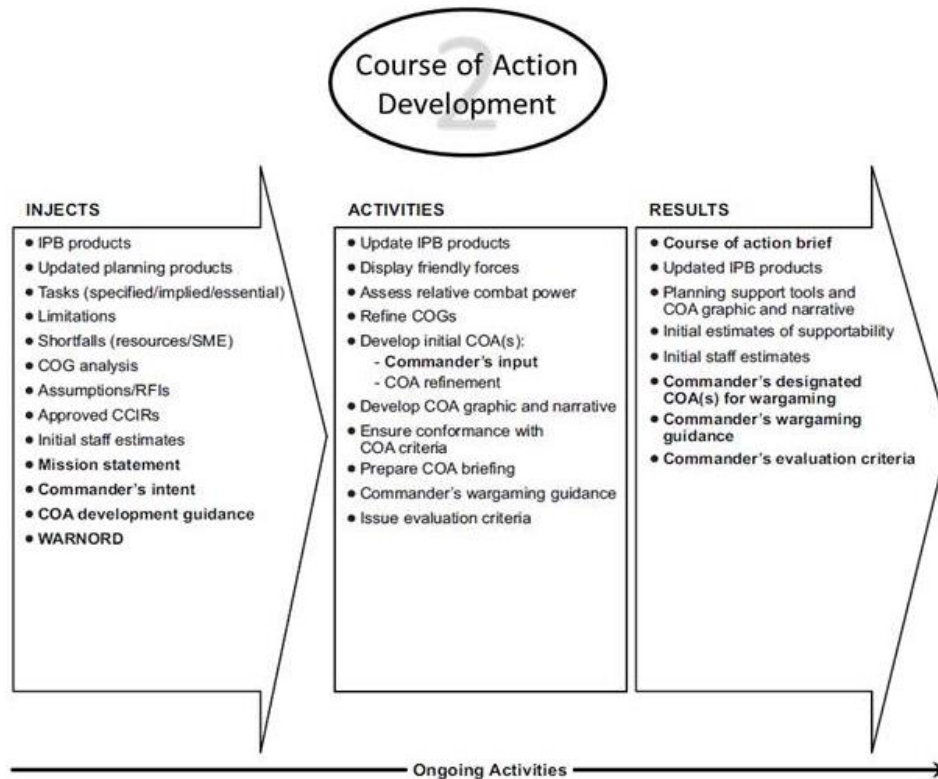| INJECTS	ACTIVITIES	RESULTS
• IPB products	• Update IPB products	• Course of action brief
• Updated planning products	• Display friendly forces	• Updated IPB products
• Tasks (specified/implied/essential)	• Assess relative combat power	• Planning support tools and COA graphic and narrative
• Limitations	• Refine COGs	• Initial estimates of supportability
• Shortfalls (resources/SME)	• Develop initial COA(s):	• Initial staff estimates
• COG analysis	- Commander's input	• Commander's designated COA(s) for wargaming
• Assumptions/RFIs	- COA refinement	• Commander's wargaming guidance
• Approved CCIRs	• Develop COA graphic and narrative	• Commander's evaluation criteria
• Initial staff estimates	• Ensure conformance with COA criteria	
• Mission statement	• Prepare COA briefing	
• Commander's intent	• Commander's wargaming guidance	
• COA development guidance	• Issue evaluation criteria	
• WARNORD		

Ongoing Activities

Figure 7.   Course of Action Development (from MSTP, 2012)

3.   Course of Action War Game

The COA war game involves a detailed assessment of each COA as it pertains to the threat and the battle space (MCWP 5-1, 2010). All friendly COA is war gamed against selected threat COAs. COA wargaming assists the planners in identifying relative strengths and weaknesses, associated risks, and asset shortfalls for each friendly COA (MSTP Pamphlet 5-0.2 2012). Additionally, COA wargaming identifies branches and potential sequels that may require additional planning. Short of executing the COA, wargaming provides the most reliable basis for understanding and improving each COA (MCWP 5-1, 2010). As seen in Figure 8, planners use the products carried forward from COA development to provide information that will allow commanders and staffs to select a COA that best satisfies the mission in accordance with the commanders' intent and guidance. PAE provides a wargaming function but does not determine success or failure; PAE assists the user in creating multiple COA, then war game them. This wargaming can take two forms, manual and automated. At the end of the war games, PAE will compare

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the war games to determine which COA is stronger based on a series of criteria that the user can modify, but the user must make determinations of success or failure (PAE Manual, 2014).
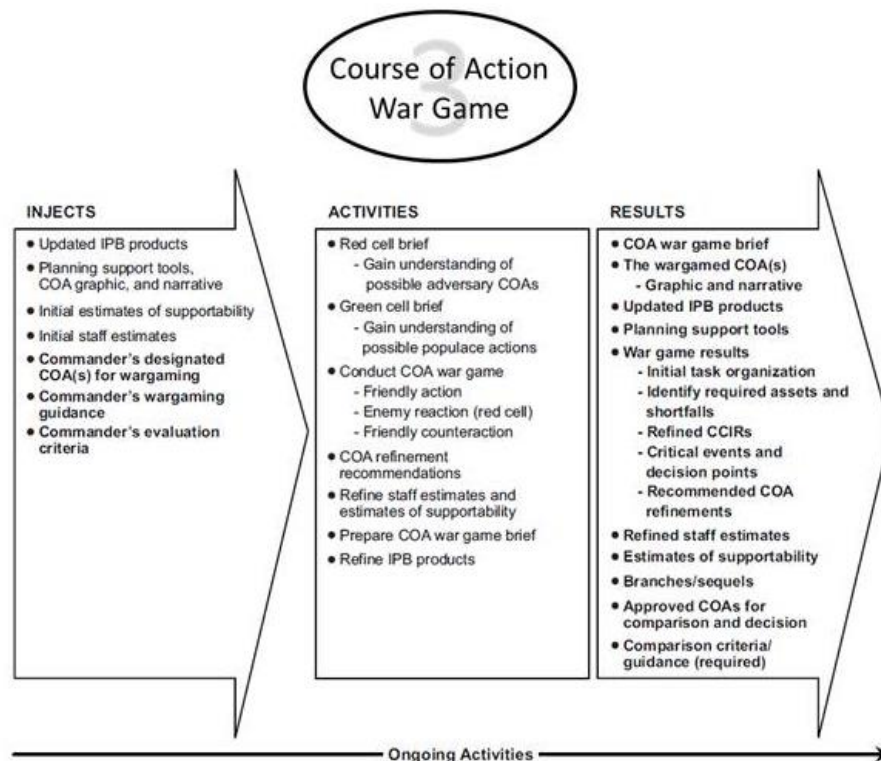

Figure 8.   Course of Action War Game (from MSTP, 2012)

4.   Course of Action Comparison and Decision

The commanders' friendly COAs are first compared against established criteria, then against each other. Based on this comparison, the commanders select the COA that they believes will best accomplish the mission (MCWP 5-1, 2010). As of note, the COA comparison and decision process at lower echelons of command may simply be an informal exchange of information between the commanders and their staffs on the results of the war game (MSTP Pamphlet 5-0.2 2012). MSTP Pamphlet 5-0.2 (2012) continues to state that at higher levels of command, the process is usually a formal sequence of activities that may involve COA evaluation, COA comparison, commanders' decision, preparation of the concept of operation, and issuance of a warning order (WARNORD).

As noted in MCWP 5-1 (2010), COA comparison and decision require war gamed COAs with graphic and narrative, list of critical events and decision points, and information on the commanders' evaluation criteria (see Figure 9). PAE provides an analytical approach by adding up all the combat values for each unit participating in a battle at a given time. It then modifies these numbers based on non-kinetic factors, places each unit in an attack or defend posture (hasty, deliberate, meeting an engagement delay), and then applies the relevant Command and General Staff College wargaming outcome to the result to determine losses for each side (PAE Manual, 2014). Furthermore, PAE provides commanders a decision matrix that details the criteria and weight of each of the COAs.
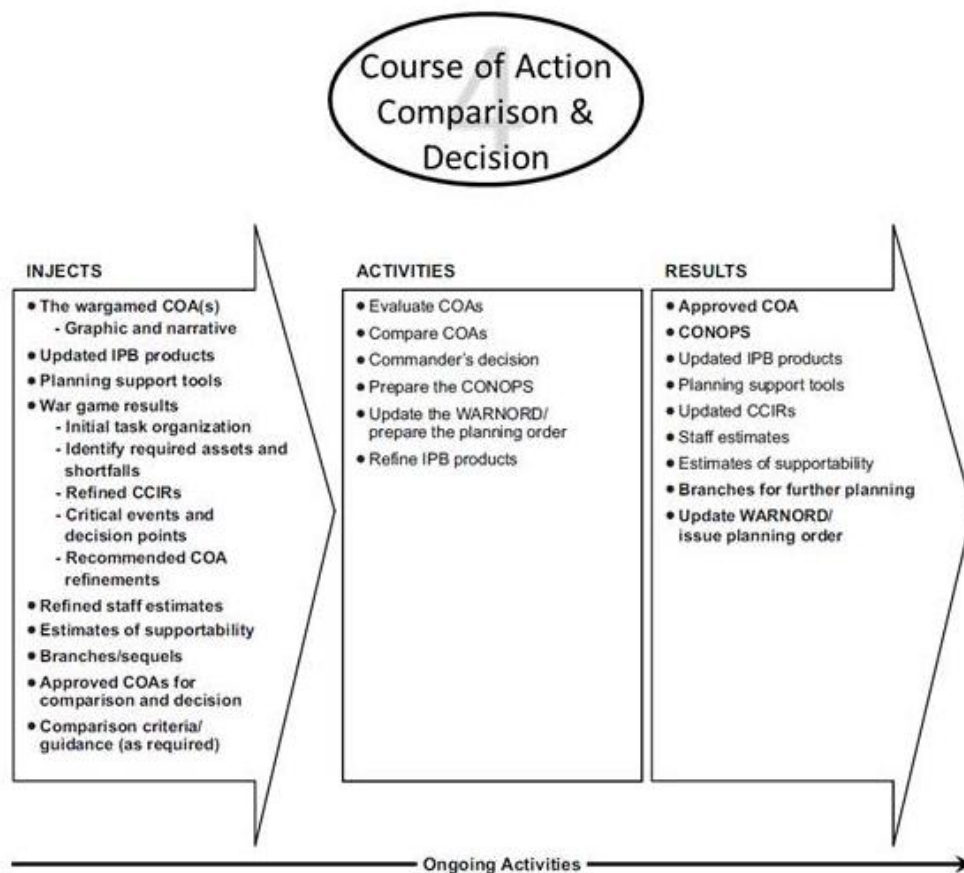

Figure 9.   Course of Action Comparison and Decision (from MSTP, 2012)

5. Orders Development

During orders development, the staffs take the commanders' COA decision, mission statement, commanders' intent and guidance, and develops orders to direct the actions of the unit (MCWP 5-1, 2010). As noted in MCWP 5-1 (2010), the development of the order begins during problem framing and continues throughout the process. Portions of the order, such as the mission statement and the CONOP, have been prepared during previous steps of the MCPP (MCWP 5-1, 2010). Furthermore, the order contains only critical or new information and not routine matters normally found in the standard operating procedures (SOP) (MSTP Pamphlet 5-0.2 2012). Orders serve as the principal means by which the commanders express their decision, commanders' intent, and guidance. Figure 10 identifies injects, activities, and results to support orders development. As seen in PAEs, OPLAN report generates a Microsoft Word document that includes all mission information and standard annex lists (PAE Manual, 2014).
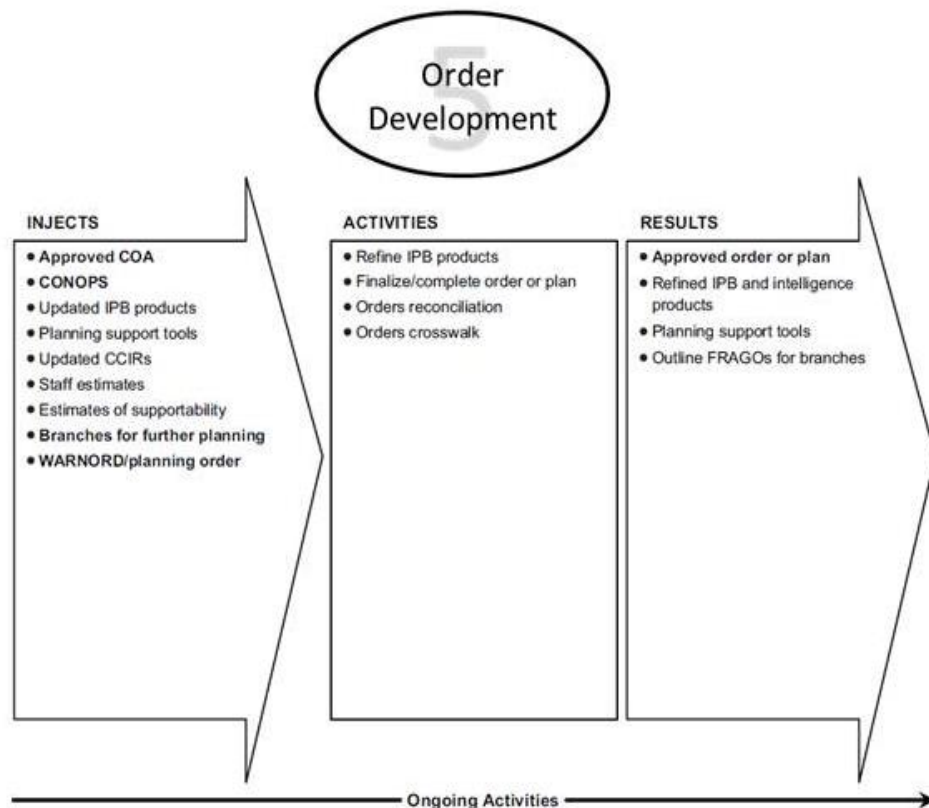

Figure 10.   Orders Development (from MSTP, 2012)

6. Transition

Transition provides a successful shift from planning to execution. It enhances the situational awareness of those who will execute the order, maintains the intent of the CONOP, promotes unity of effort, and generates tempo (MCWP 5-1, 2010). Transition may involve a wide range of briefs, drills, or rehearsals necessary to ensure a successful shift from planning to execution. It is a continuous process that requires a free flow of information between commanders and staffs by all available means (MSTP Pamphlet 5-0.2 2012). A number of factors can influence how the transition step is conducted, such as echelon of command, mission complexity, and most importantly, available time. As Figure 11 illustrates, the injects, activities, and results columns must support the transition of information through all levels of command. As seen in PAE, two methods for presenting PowerPoint briefings and report features can assist commanders and staffs with writing an operations plan or order and disseminating the information to HHQ or subordinates.
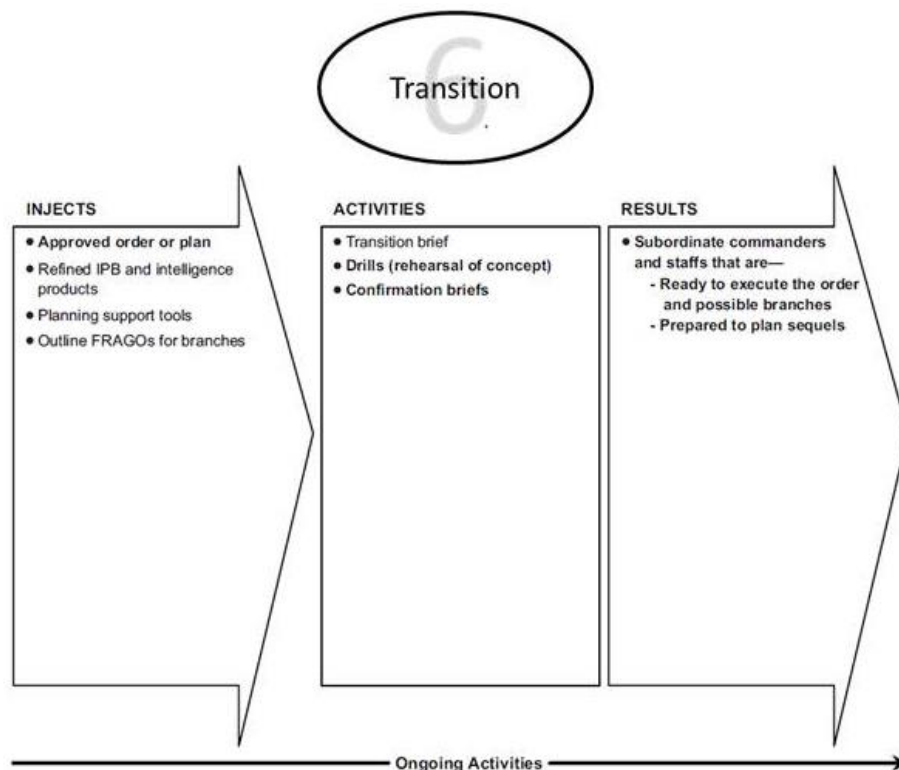

Figure 11.   Transition (from MSTP, 2012)

G. RAPID RESPONSE PLANNING PROCESS

The purpose of the R2P2 is to spend the least amount of time planning while providing the executing forces with the maximum time allowable to prepare for the mission. R2P2 enables a unit (such as a MEU) to receive, analyze, plan, and coordinate a mission within six hours of notification (MSTP Pamphlet 5-0.2 2012). The standard is to commence the mission within six hours of tasking. Mission commencement does not necessarily mean "landing the landing force" (p. 143, para. 1) or securing the objective. It could be as simple as launching a reconnaissance and surveillance (R&S) team. The point is some action of execution needs to occur within the six-hour time frame (MCWP 5-1).

1. Rapid Planning Considerations

The following points may provide context when using R2P2. First, anticipate the mission by looking at potential missions and areas of interest prior to deployment. Using theater threat briefs, cultural briefs, and economic briefs regarding the regions in which expeditionary forces will be operating, helps to build situational awareness (SA). Second, establish and validate SOPs to establish a battle rhythm for a unit to conduct operations. A process is needed to develop a battle rhythm in which all units will operate in a cohesive manner. This process becomes a unit's SOP. Third, a planning cell must establish various missions' sets and their required planning spaces should be established prior to deployment. The staffs should know the roles and functions of each of the planning cells. Fourth, information flow is essential when using both MCPP and R2P2. Knowledge is needed to make informed decisions, and focusing on the commander's critical information requirements (CCIR) mitigates information saturation and allows the staffs to concentrate on the information the commanders have deemed critical to accomplishing the mission. Last, solid communications provide the link for commanders and staffs to real time information.

2. Marine Corps Planning Process and Rapid Response Planning Process

The R2P2 planning process is the same as the MCPP with some modifications due to time constraints. The problem-framing step is essentially the same. During R2P2,

COA development is limited to three COAs; the COA war game is informal and two of the three COAs are compared. Once a COA is selected, the confirmation brief constitutes the order, and rehearsals are the primary means for subordinates to show understanding of what is needed in mission execution.

H.   SUMMARY

As noted by Maier and Rechtin (2002), warfare is an open collaborative system because no one stakeholder has total "coercive power to run the system." As the complexities of military operations continues to change, no one leader exercises total control but ultimately depends on cooperation from other stakeholders for the achievement of operational orders (Checkland & Poulter, 2006). As seen, PAE's collaboration server was developed to work on an Enhanced Position Location and Reporting System (EPLRS) network, with most graphics being transmitted using minimum bandwidth consumption. This chapter outlines theories, tenets, and process that increase the persevered usefulness of PAE. As seen in Figure 12, TAM continues to build on the framework of PU and PEOU, which will influence the BI, and ultimately, the adoption of PAE.

Design Theory
Marine Corps Planning Theory
Tenets of the Planning Process
Warfighting Functions
Marine Corps Planning Process
R2P2

Perceived Usefulness (U)

External Variables

Perceived Ease Of Use (EOU)

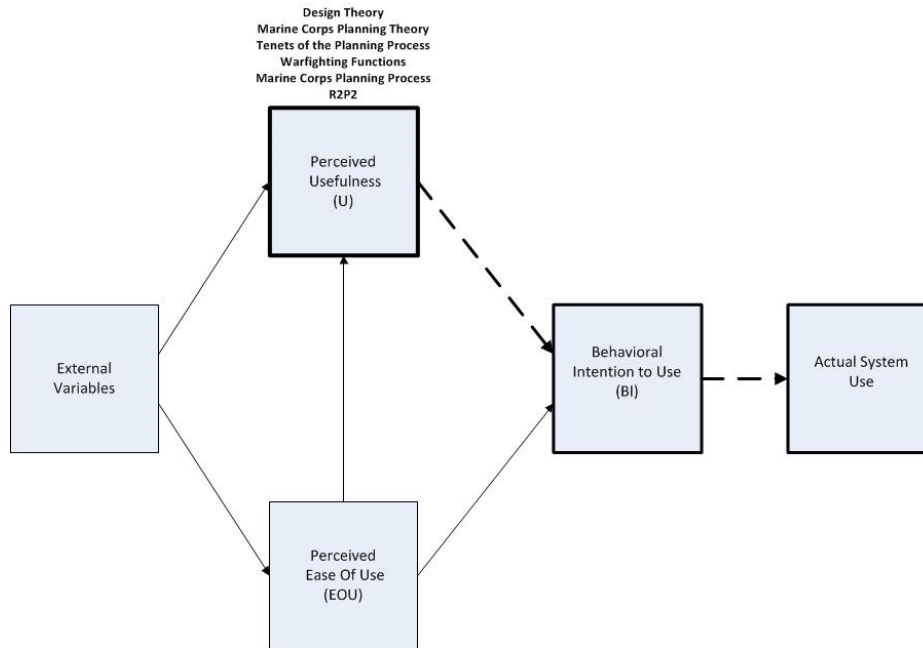Behavioral Intention to Use (BI)

Actual System Use

Figure 12.   PU Using TAM (from Davis, 1998)

As exemplified in MCWP 5-1 (2010), commanders and staffs need information for both MCPP and R2P2 in the form they can quickly and easily understand during planning and decision making. The Marine Corps planning theory and process provide well for planning at the tactical level at which the system is easily understood from experience or previous study. However, it is at the higher levels where its weaknesses is exposed. The MCPP lacks robust tools and applications for creating an operational architecture. The reduction in resources and the global nature of political and social unrest force the U.S. military to analyze efforts to use integrated information that can lower uncertainty and risk in military operations (McKearney, 2013). As a solution, PAE enables a robust platform that provides planners a doctrinal structure that allows consistency in information. As seen using TAM, the use of PAEs will increase the knowledge of both commanders and staffs, which influences the behavioral intention, and PU of technology.

Chapter III details the technology platforms within a MAGTF and continues to illustrate that PAE, if leveraged correctly, will provide a robust platform for the PU and PEOU of technology.

III. MARINE CORPS INFORMATION SYSTEMS

A. INTRODUCTION

The MAGTF employs information systems to support the collection, processing, and exchange of information. Information systems can accelerate and automate routine functions to allow commanders and staffs to concentrate on those aspects of command and control requiring expertise, understanding, and intuition. As stated in MSTP Pamphlet 6-0.2 (2012), in every aspect of operations, these systems serve the commanders and their staffs by facilitating rapid, secure information flow, shared situational awareness, informed decision making, and swift dissemination of decisions. The success of the MAGTF in the modern battlespace depends heavily on the effective employment of information systems (MCWP 3-40.1, 2003). To understand the Marine Corps technology adoption challenges better, specifically using PAE, the continued analysis of TAM will add to the framework provide in Chapter II. This chapter provides the context of current systems within the MAGTF that allow commanders operational reach. Furthermore, this chapter illustrates where PAE is within JTCW, which will provide a better understanding of PAE's functionality. Furthermore, this chapter builds on the element of perceived EOU, which is "the degree in which a person believes that using a particular system would be free of effort" (Davis, 1989).

B. MAGTF COMMAND AND CONTROL

The C2 process empowers commanders to exercise command across the span of their forces (MCWP 3-40.1, 2003). It establishes a context for the commanders to develop an understanding of the situation, determine actions needed to be required, and through technology, transmit information to subordinate commanders. Furthermore, C2 allows the commanders' staffs and planners to monitor the performance of information and evaluate the results. C2 also requires an understanding in how people, information, and support (Figure 13) influence the quality of C2 during operations while influencing their BI towards a particular technology.
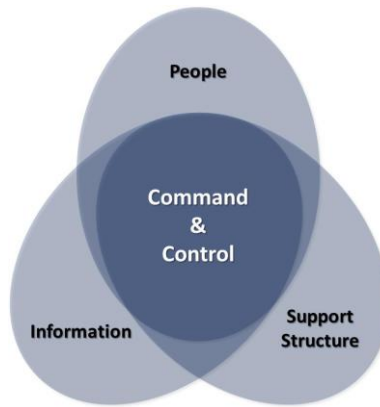
Figure 13.   Three Elements of Command and Control
(from MSTP Pamphlet 6-0.2)

1.   People

People are the foundation of C2 systems. People are the starting point for C2, and with a common philosophy, they can gather information, make decisions, take action, communicate, and cooperate with one another to accomplish a common goal (MCWP 3-40.1). Ultimately, through the use of information, people are empowered within a command to create diffusion to adopt a new idea, behavior, or product (Rogers, 1995).

2.   Information

Information provides a context of reality, and influences decisions and actions. As noted in MCDP 6 (2003), information is represented by several mediums, like words, letters, numbers, images, and symbols that allow commanders and staffs an understanding of things, events, ideas, and values. Additionally, information provides a platform for commanders, staffs, and planners to assess communicate and modify actions during operations. As illustrated in MCDP 6 (1996), information can be used for two basic uses.

- To help create situational awareness as the basis for a decision
- To direct and coordinate actions in the execution of the decision

3.   Support

Support structure aids the people who create, disseminate, and use information. It includes the organizations, procedures, equipment, systems, facilities, training, education, and doctrine that support C2 (MCWP 3-40.1, 2003).

C.   INFORMATION THEORY

It is important to recognize that information comprises everything from raw data to detailed data that has been comprehensively filtered and analyzed. As seen in Figure 14, MCWP 3-40.1 illustrated a four-step cognitive process that transitions raw data into comprehensive information that provides SA. This cognitive process supports Roger's (1995) innovation-decision process, which involves five main steps: knowledge, persuasion, decision, implementation, and confirmation. Innovation (technologies) enables the collection of raw data as seen in information theory and MAGTF information management.
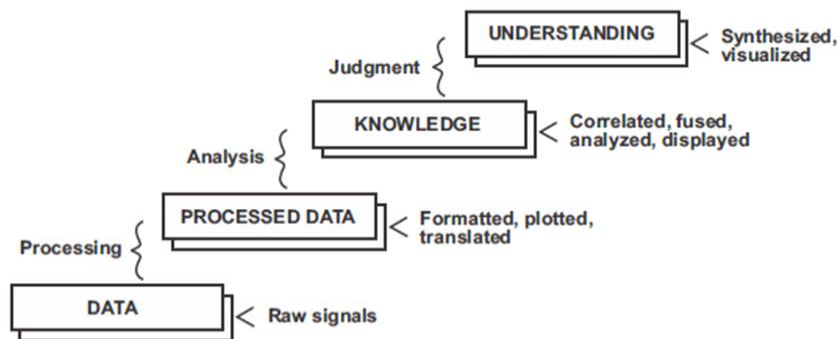

Figure 14.   Information Hierarchy (from MSTP Pamphlet 6-0.2)

1.   Collect Raw Data

Collected raw data (knowledge) can come from a variety of sources, such as satellite signals, radio signals, meteorological data from a weather balloon, or even bar-coded logistic data scanned from the side of the container (MCWP 3-40.1, 2003). This data can be transmitted over analog or digital media. Ultimately, the information must be translated into usable data.

2. Process Data

As noted in MCWP 3-40.1 (2003), the act of handling data like decoding, filtering, and other varied means, allow commanders and staffs to glean the necessary information for a specific mission. Once data has been processed, it may have immediate value for Marines in close contact with the enemy. Such information is known as *combat information*, which is ordinarily very perishable and must be propagated to units as rapidly as possible (MCWP 3-40.1, 2003).

3. Analyze and Evaluate

Through examination and evaluation, data is transformed into information and intelligence that develops the knowledge needed to assist decision making; e.g., the analysis of intelligence information provides a picture of the enemy situation (MCWP 3-40.1, 2003). While a few elements of that image may have been provided by combat information, interpretation and evaluation afford a more realistic and comprehensive understanding of the enemy situation.

4. Situational Awareness

As illustrated in MCWP 3-40.1 (2003) SA entails developing an understanding of the situation on the basis of the information available. Understanding is the result of applying human judgment based on individual experience, expertise, and intuition to achieve a full appreciation of the battlespace. This understanding is what is known as SA, and it provides a sound basis for operational decisions. SA allows the commander to anticipate events and to uncover critical vulnerabilities for exploitation (MCDP 6, 1996). As staffs endeavor to achieve an understanding of the circumstances, staffs must recognize that time works against them. Staffs may not be able to gain complete SA before acting. Developing SA with limited and uncertain information under severe time constraints is the fundamental challenge of command and control.

D. MAGTF INFORMATION MANAGEMENT

As described in MCWP 3-40.1 (2003), information management allows a flow of pertinent information that establishes a foundation for all facets of the planning, decision,

execution, and assessment (PDE&A) cycles of organic and discrete units. Through automation, information can be displayed dynamically to provide a rapid immersion of information that allows for efficient decision making. Effective information management delivers decisive information in an appropriate fashion to those who need it in a structure that can be quickly understood. Furthermore, information management includes all actions that involve recognizing, handling, refining, fusing, processing, and directing information (MCWP 3-40.1, 2003). This assembly of information provides an understanding of the battlespace that allows the commanders to develop and analyze decisions better and communicate those decisions. The commanders must leverage information management to maximize SA, quality information, and establish CCIRs.

1. Obtaining Situational Awareness

As defined in MCWP 3-40.1 (2003), SA is advancing the understanding of the situation on the basis of the information accessible. Additionally, the understanding of the information received is the effect of applying human interpretation based on personal experience, expertise, and intuition to gain a full visualization of the battlespace as seen in Figure 15. As illustrated by McKearney (2013), this understanding is what constitutes SA and provides a sound basis for operational decisions. SA allows the commanders to anticipate events and to uncover critical vulnerabilities for exploitation. Developing SA quality of information is critical, and with limited and uncertain information, coupled with severe time limitations, becomes the central challenge of C2 (MCWP 3-40.1, 2003).
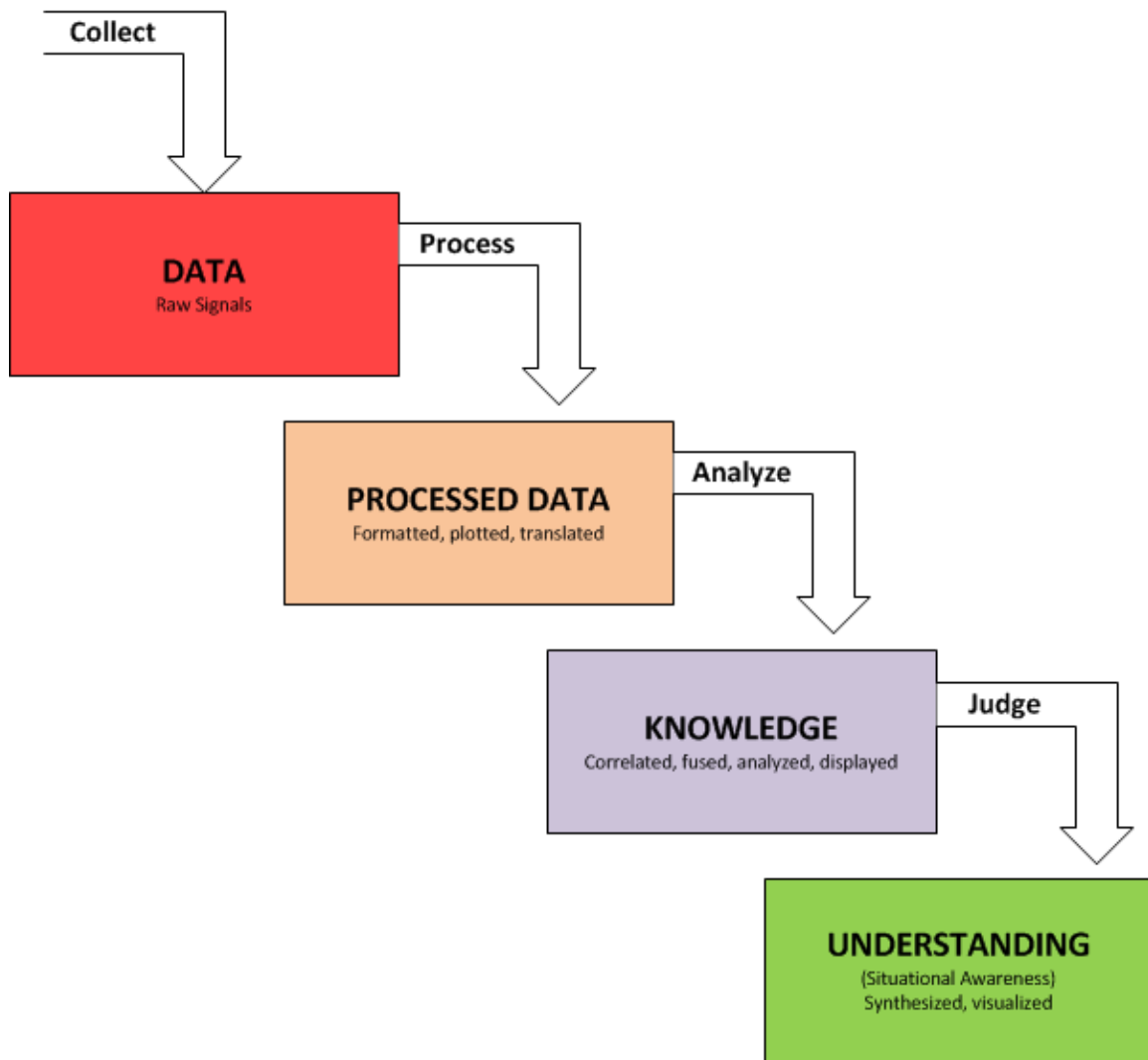
Figure 15.   Information to Situational Awareness (from MSTP Pamphlet 6-0.2)

2.   Quality Information

As noted in MCWP 3-40.1 (2003), information must have specific qualities to have value. Information that lacks relevance, timeless, accuracy, and completeness may be detrimental to decision making. Relevance of information is essential to the mission, and if information is provided without filtering, it often detracts from the commanders' ability to make timely, effective decisions. Timeliness of information must be accessible at the proper place and time to be beneficial and information management procedures must ensure the timely, unimpeded flow of relevant information (McKearney, 2013). Accuracy of information must be as detailed as possible, and through information

systems, must be collected, collated, and displayed for staffs to evaluate and make decisions as to its accuracy, timeliness, and relevance. Completeness of information allows commanders to have relevant, timely, and accurate information during decision making. Nevertheless, if staffs and subordinates are aware of the commanders' intent and CCIRs, they can provide the information required through two easy steps (MSTP 6-0.2, 2012).

Objectively, information must be provided in the most undistorted, factual, and unbiased way possible. Any assumptions or interpretations should be highlighted (MCWP 3-40.1, 2003).

As illustrated in MSTP 6-0.2 (2012), usability is the display or presentation of information that must be understandable and useful. Standard and clear formats, symbols, and terms should be used. Information exchanged and presented in nonstandard methods delays interpretation and is more easily misunderstood; thereby, leading to longer decision and execution cycles, and ultimately, to less reliable decisions (MCWP 3-40.1, 2003).

3.   Commander's Critical Information Requirements

MCDP 6 (1996) establishes only a fraction of the accessible information that in theory can be collected and processed rapidly enough to support decision making. As stated previously, the commanders identify CCIRs to concentrate and regulate the gathering and processing of data. CCIRs represent information regarding the enemy—its own forces, and the environment that the commanders deem critical to maintaining situational awareness, planning future activities, and making timely decisions. Designating CCIRs decreases the amount of information, which needs to be reported to the commanders and guides staff efforts on collecting relevant and timely information (MSTP 6-0.2, 2012).

E.   SHARED SITUATIONAL AWARENESS

The capability to share a common picture of the battlespace has been assigned the highest priority in current efforts to improve C2 capabilities (MCWP 3-40.1, 2003).

Furthermore, at the combatant commander level, this battlespace picture is a common operating picture (COP), which is a composite of the battlespace pictures of subordinate commanders' common tactical picture (CTP) (MTSP 6-0.2, 2012). The COP/CTP enables commanders in different geographic scenes and services to observe and evaluate the military situation collaboratively, make decisions on current operations, and transmit those decisions to the appropriate forces (MCWP 3-40.1, 2003). Procedures must also be in place to track and display properly the data being submitted to a database driving the CTP/COP.

1. Common Operational Picture/Common Tactical Picture

COP information is required at all levels (MCWP 3-40.1, 2003). Commanders control the information in their areas of responsibility by establishing a COP or CTP correlation site to pull information together, build a general tactical data set, and apply overlays, and filter information (MSTP 6-0.2, 2012). Subordinate commanders develop and submit their CTPs, which are correlated and fused for inclusion in the next HHQ COP. The chart application of the JTCW is the primary tool used for viewing the data in the COP/CTP, which generates the situational display from the track database (MTSP 6-0.2012). Accuracy of the situational display depends completely on the quality and timeliness of data information from multiple sources and the effective correlation and fusion of that data (MCWP 30.1, 2003).

2. Track Database Management

The COP/CTP is developed through the concept of tracks. A track represents an object in graphic or text format. The position and characteristics of that object—which may be a friendly or enemy ship, aircraft or ground unit—are collated from sensors and other data sources including manual input. Normally, tracking is through a combination of automated and manual procedures. Although much of the track data is fed into the database, correlated, and displayed automatically, the data must be managed efficiently to prevent obsolete tracks from being displayed (MSTP 6-0.2, 2012). Each command level that generates input for a COP/CTP has the responsibility for track management:

entering, correlating, updating, fusing, de-conflicting, and otherwise, maintaining assigned tracks, which is done using information systems.

F.   MAGTF INFORMATION SYSTEMS

As noted in MCWP 3-40.1 (2003), the MAGTF information systems are a part of the MAGTF C2 support structure. The MAGTF communication and information systems plan supports communication requirements, which include the networks required for information system connectivity (MTSP 6-0.2, 2012). As illustrated in Figure 16, all these plans link the six warfighting functions to 30 different systems. Paragraphs 1 through 6 provide descriptions of all the C2 systems currently in use by the MAGTF (MTSP 6-0.2, 2012). Theses systems provide a link between information thoery, MAGTF information management, while framing the innovation-decision process.

As Roger (1995) discribes, knowledge occurs when an innovation's existence (PAE) is gained and a desire to gain some understanding of how it functions. Persuasion is a change in an individual's attitude toward the innovation (PAE), which is either favorable or unfavorable (Rogers, 1995). Rogers continues to define decision as an individual selecting to adopt or reject an existing innovation (PAE). The following section details the current systems with the MAGTF, and provides the finshing elements (implementation, and confirmation) of the innovation-decision process.
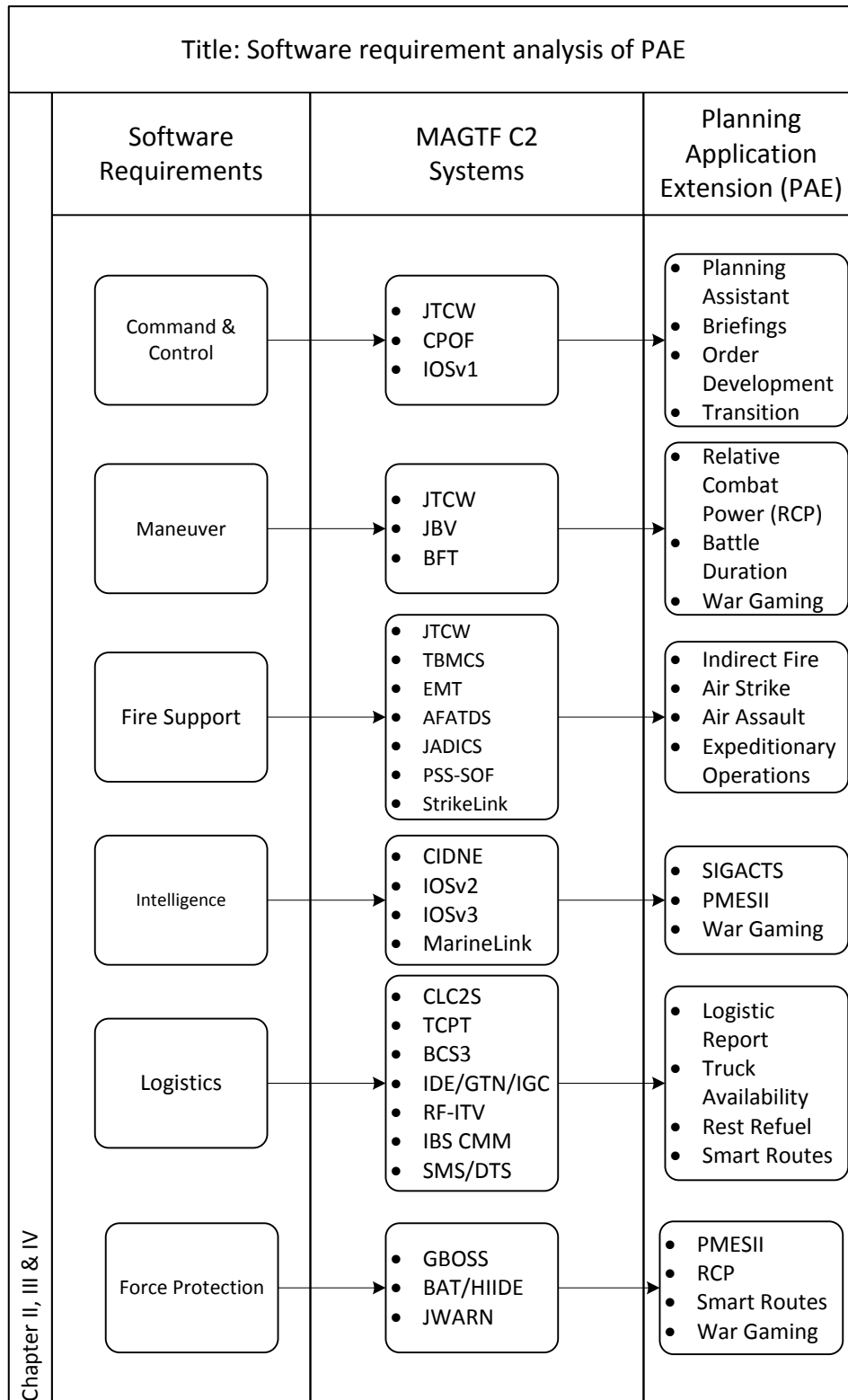
Title: Software requirement analysis of PAE		
Software Requirements	MAGTF C2 Systems	Planning Application Extension (PAE)
Command & Control	• JTCW • CPOF • IOSv1	• Planning Assistant • Briefings • Order Development • Transition
Maneuver	• JTCW • JBV • BFT	• Relative Combat Power (RCP) • Battle Duration • War Gaming
Fire Support	• JTCW • TBMCS • EMT • AFATDS • JADICS • PSS-SOF • StrikeLink	• Indirect Fire • Air Strike • Air Assault • Expeditionary Operations
Intelligence	• CIDNE • IOSv2 • IOSv3 • MarineLink	• SIGACTS • PMESII • War Gaming
Logistics	• CLC2S • TCPT • BCS3 • IDE/GTN/IGC • RF-ITV • IBS CMM • SMS/DTS	• Logistic Report • Truck Availability • Rest Refuel • Smart Routes
Force Protection	• GBOSS • BAT/HIIDE • JWARN	• PMESII • RCP • Smart Routes • War Gaming

Chapter II, III & IV

Figure 16.   Information System by Warfighting Functions
(from MSTP 6-0.2, 2012)

G.   MAGTF COMMON OPERATING PICTURE

1.   Joint Tactical COP Workstation

To finish the analysis of the innovation-decision process, an implementation and confirmation occur by either using the innovation—this case JTCW—and seeks to validate the decision to using a particular innovation (Roger, 1995). According to USMC Concepts and Programs (2011), the JTCW provides a military C2 platform for enhanced SA. Operational and tactical decision making is accomplished through a Windows-based tactical COP workstation, which is a suite of applications designed for battalion and higher level commands. The JTCW supersedes the Command and control personal computer (C2PC) software by consolidating C2PC with other joint applications into a single software load to provide comprehensive aptitude for C2 planning and interoperability (USMC Concepts and Programs, 2011).

The warfighter is provided an enhanced platform through the JTCW interoperability and allows a conduit between MAGTF systems for command, control, communications, computers, and systems for intelligence, surveillance, and reconnaissance (C4ISR) (USMC Concepts and Programs, 2011). As seen in Figure 17, JTCW gives an initial point of entry for the COP. JTCW allows users to establish a collaborative environment by viewing map data, transfer general message traffic, plan and distribute route information, view and update track data, develop and distribute overlays, and provide general C2 planning information (MSTP 6-0.2, 2012). JTCW software is loaded on the intelligence operations workstation (IOW) and is integrated into the MAGTF combat operations centers (COC) (USMC Concepts and Programs, 2011). Untimely, at the end of the innovation-decision process, a decision is made to make full use of an innovation (i.e., adoption), or not use the innovation (i.e., do not adopted). In this case, JTCW has been adopted and is the central C2 system in a MAGTF.
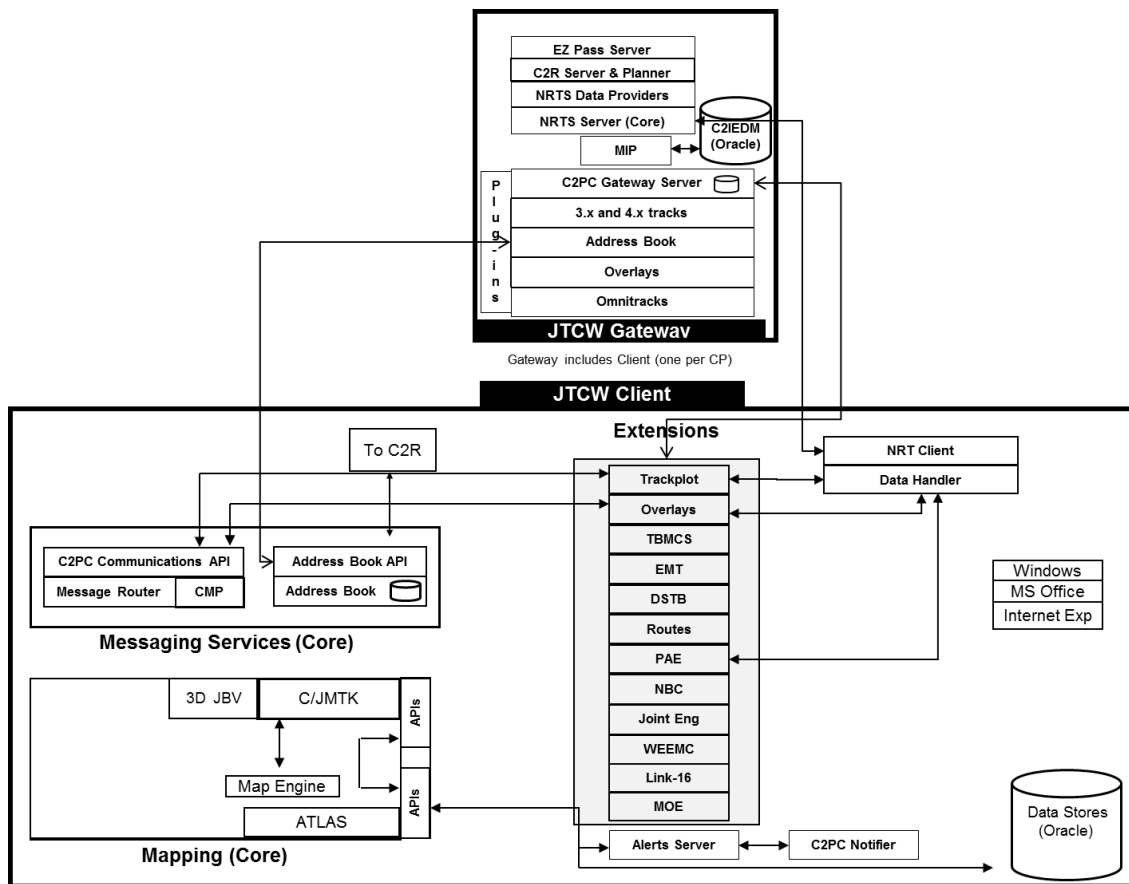
Figure 17.   JTCW Model

H.   SUMMARY

Wentz, Barry, and Starr (2009) explain that over the last 20–30 years, the Marine Corps' C2 environments have evolved because of operational requirements. This environment is conducive for BI of an end user and builds the understanding of PU and PEOU. Although the Marine Corps has experienced progress in enterprise-wide IT management, supplementary research must focus on current C2 systems to provide an operational reach for MAGTF operations. Creating networked capabilities is a critical component of the MAGTF approach to command and controlling Marine forces. Commander, staff, and unit are all known as nodes and can be a producer, processor, and user of information (McKearney, 2013).

As noted by Wentz, Barry, and Starr (2009), all information must be readily available for these nodes without overloading or paralyzing them with irrelevant

information. Furthermore, many of the nodes in the system are required to perform multiple functions; therefore, the essence of MAGTF C2 is decentralized and highly adaptive (McKearney, 2013). MAGTF C2 uses the communication's architecture and information systems to nurture and use the human capacity for shared understanding, absolute information, and instinctive decision making, which has influenced the adoption of JTCW. The combined network effect, produced by organizing all nodes into an information-rich, collaborative, global system, is needed to increase these inherently human qualities (Wentz, Barr, & Starr, 2009).

To maintain the superiority of these MAGTF information capabilities, the Marine Corps must have a plan to integrate new and proven technologies continually as they become viable and affordable. The increasing numbers of information systems that do not integrate standardized data place an ever increasing burden on the time and funding required for operations, maintenance, and training (Wentz, Barr, & Starr, 2009). As an extension of JTCW—that is already a system of record—PAE provides a power platform for information gathers and support BI through PAE's PU and PEOU. See Figure 18. The following chapter provides background and outlines PAE's special functions while using KVA to assess PAE's ROK.
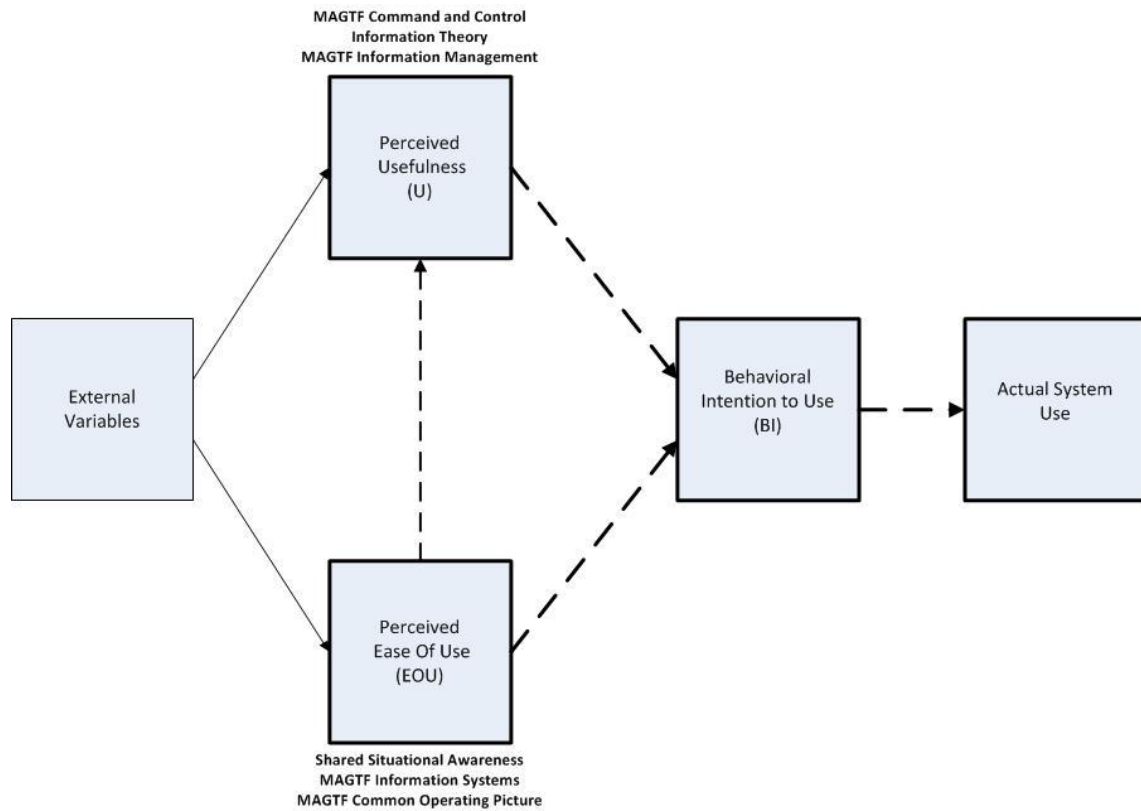
Figure 18.   Perceived Ease and Usefulness Using TAM (from Davis, 1989)

IV. ANALYSIS

A. INTRODUCTION

The purpose of Chapter IV is to provide background for PAE and analysis to answer the questions presented in this thesis. Furthermore, by using the Expectation Continuance Model (ECM), a framework is developed to determine if PAE is a viable technology innovation and build PAE's PU and PEOU. According to Bhattacherjee (2001), post-adoption expectation, satisfaction, confirmation, and continued IT usage intention are elements of ECM that help identify areas of concerns in the adoption of technologies. As seen in Figure 19, PAE is a software extension designed for JTCW that supports planners in all aspects of planning. In conversation with Mr. Savinovich (2013), "PAE has been in the MAGTF since 2009, his concern is only 70 Marines have trained on PAE." Savinovich (2013) continues to state that PAE frees planners from most of the routine tasks associated with operational planning, and by using PAE, planners can focus on higher level concepts missions, plans, tasks, and activities.
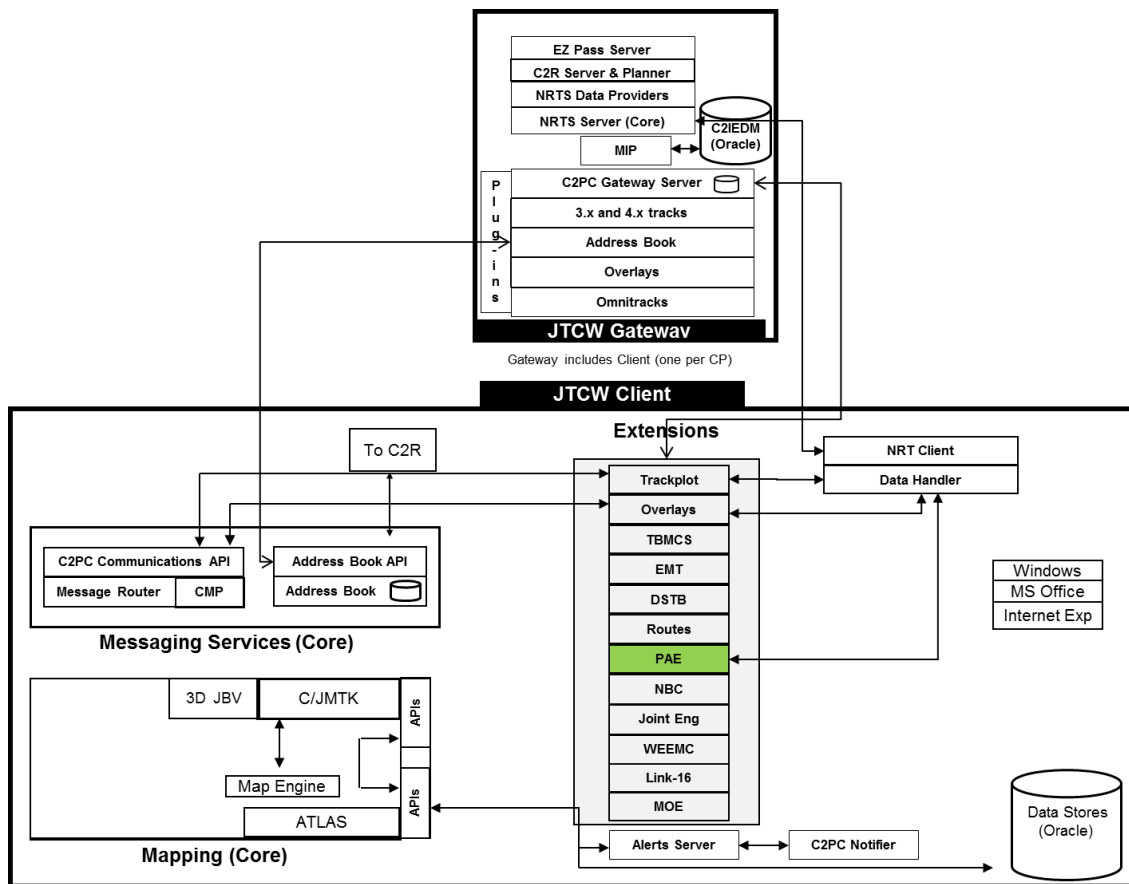
Figure 19.   JTCW Model with PAE

PAE enables OPTs to use graphical and simulation technology during both MCPP and R2P2 sessions. Specifically, PAE allows planners to define tasks and see the effect of those tasks over a period of time while leveraging the simulation features that allow planners to replay tasks during each planning phase. Planners are able to use the GUI to import data from various databases to help in planning. Furthermore, as stated by Savinovich (2013), PAE permits multiple planners to share plans with others to create a collaborative environment during military operations. The aforementioned elements continue to frame the impact PAE will provide to commanders, staffs, and planners BI towards PAE's PU and PEOU.

B. IS THERE AUTOMATION THAT WILL ENHANCE PLANNING DURING THE MARINE CORPS PLANNING PROCESS?

Automation can enhance any process if leveraged correctly as seen during the analysis of PAE. PAE provides planners with a tool called "the planning assistant," which can be used in a collaborative environment. The planning assistant allows planners to collaborate on changes made to the checklist and post documents to an accessible location to allow information sharing in real time (Savinovich, 2013). As seen in Figure 20, PAE enables a collaborative environment through the use of GUIs; these interfaces will take the planner through each step of MCPP and R2P2. These GUIs allow an increase in post-adoption expectation, which is defined as the related causes of a user's level of satisfaction with IT (Bhattacherjee, 2001).
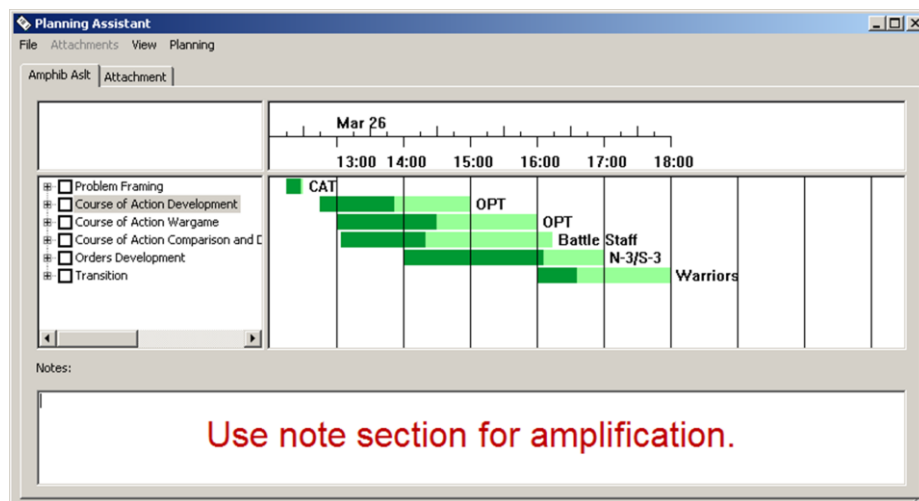
Figure 20.   Planning Assistant (from Savinovich, 2013)

As discussed during the COA development section earlier in this document, PAE allows planners to define many COAs, each with a separate user-defined name and set of properties (PAE Manual, 2013). Savinovich (2013) explains that once a planner defines a given COA, planners are able to re-use any task organizations or plans in various scenarios, which decreases the amount of time required for branch planning or "what-if" analyses. PAE provides a step in the right direction by linking current MAGTF C2 systems (e.g., JTCW) and providing an intuitive platform for collaboration. Even more

importantly, PAE provides a doctrinal base process of MCPP that will enable the less experienced planner the ability to provide the commanders a consistent quality of information.

C. HOW WILL PLANNING APPLICATION EXTENSION SOFTWARE DESIGN ENHANCE CAPABILITIES WITHIN THE OPERATIONAL PLANNING TEAM?

PAE uses powerful behavioral models that give planners the science of war, which allows them the ability to focus more on the art of war (Savinovich, 2013). Moreover, PAE enhances the OPT's ability to leverage AI. During wargaming, PAE leverages these behavioral models to provide OPTs the opportunity to compare several COAs at the same time. As seen in Figure 21, PAE allows planners to develop multiple COAs and then simulate them. During the simulation, PAE pulls information from Total Force Structure Management System (TFSMS) to develop a unit composition and organization. This information is later used to determine the range at which battle commences and to direct range fan values (i.e., the maximum distances a particular weapons platform can engage a target).
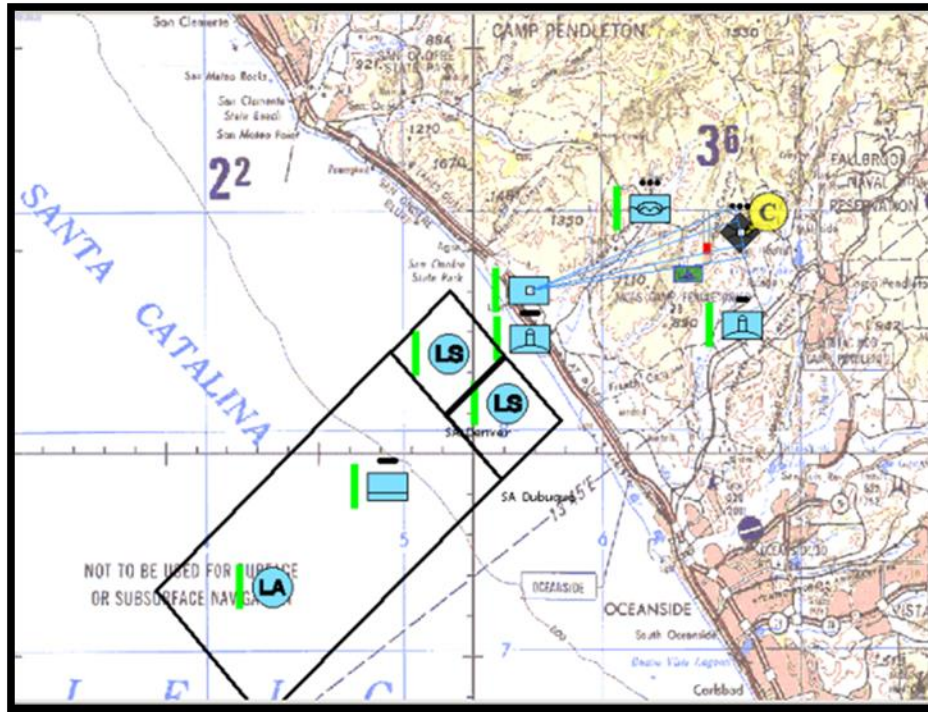
Figure 21.   WarGaming (from PAE Manual, 2013)

PAE performs three fundamental battle calculi. During combined arms or close battles, PAE adds up all the combat values (relative combat power and strength, weapons ranges for each unit engaging) in a battle at a given time (PAE Manual, 2013). It then modifies these numbers based on non-kinetic factors, places each unit in an attack or defense posture (hasty or deliberate), and then applies the relevant Command and General Staff College (CGSC) wargaming outcome to the result to determine losses for each side (Curry, 2013).

1.   Relative Combat Power

Planners can review the RCP values associated with units assigned to the active COA during wargaming (PAE Manual, 2013). By using the RCP model, all aircraft, indirect fire, and direct fire systems are reduced to their RCP drawn from the National Simulation Center at Fort Leavenworth, KS (Curry, 2013). RCP methodology is a mathematical method for solving complex battlefield problems. Each platform is assigned a point value based off the National Simulation Center numbers. As seen in

Figure 22, RCP function allows planners to select friendly and enemy units and then display aggregated RCP values and ratios of friendly to enemy units for the selected units.
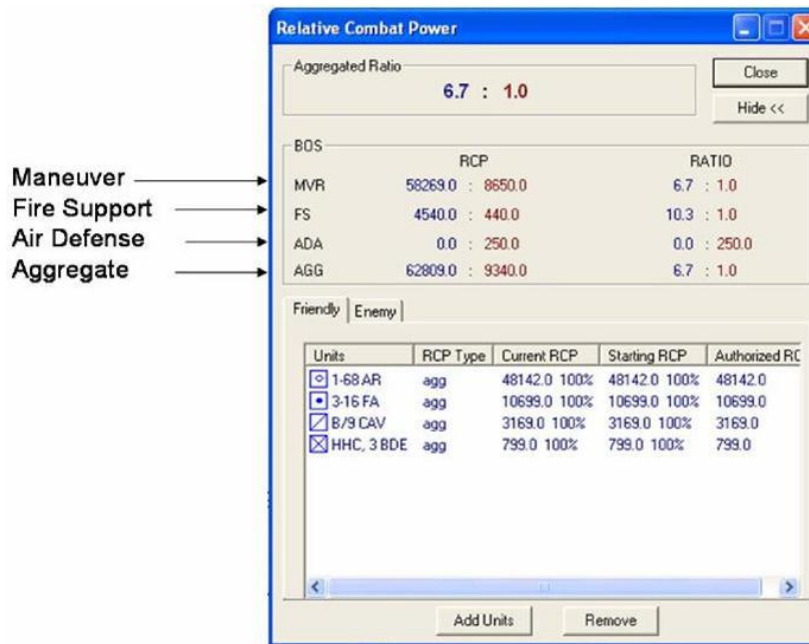
Figure 22.   Relative Combat Power Details Window (from PAE Manual, 2013)

To illustrate this scenario, Savinovich (2013) explains that a M1A1 tank is worth 950 combat points and a T-55 tank is worth 500 combat points. The base line number gives a USMC tank a 2:1 advantage over the enemy tank. This number is rolled up to the unit level. Thus, a USMC tank company is worth 13,300 points (14 tanks X 950 points) and the enemy tank company at 70% strength is worth 3,500 points (7 tanks X 500 points). Therefore, the RCP is 3.8:1. PAE rounds this number up to 4:1. The posture of the two sides (each side has as many units as desired) is entered. Therefore, in this example, the tank company is conducting a hasty attack against a hasty defense, and for every one of the tanks lost to combat, the enemy would lose six tanks (exchange ratio of 1:6).

This simulation shows the utility PAE brings to planners fingertips. PAE enables planners to account for not only tangibles (e.g., M1A1) but also the intangibles like

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leadership, training, and morale. Planners are able to increase the combat power of any unit incrementally using the sliders at the bottom of the unit status tab of the unit properties window (Savinovich, 2013). Using the slider not only effects changes to the RCP but the battle duration of the unit as well.

2. Battle Duration

Battle duration is established by calculating the average rate of march against enemy resistance using CGSC (Curry, 2013). In this simulation, each unit is provided a defensive footprint for frontage and depth of a security zone and Main Battle Area (MBA). As illustrated in Figure 23, the terrain, RCP of the forces, the unit's posture of both attacker and defender, and day/night condition, determines the speed of the attack through the defense (PAE Manual, 2013). When the attack has reached the end of the enemy defense, PAE will terminate the action.

Figure 23. Close Battle Duration Calculator (from PAE Manual, 2013)

3. Indirect Fire

PAE allows planners to attack enemy targets using artillery, mortars, and rockets only. In this model, PAE does not use RCP, but calculates the effects of the round type and caliber on the target array being engaged (Savinovich, 2013). Each indirect fire

platform has data about its caliber, sustained and maximum rate of fire, and reload times within PAE. As seen in Figure 24, the planner tells the system to create an indirect fire event, and then inputs how much attrition to achieve. Savinovich (2013) continues to explain that PAE examines the target unit composition and determines how many rounds of the ammunition type available in the firing unit will be required to achieve the desired end state, based on the target unit's status. PAE then determines how long it takes to fire that number of rounds from the available tube or launchers from the designated firing units. PAE pulls information from the Joint Munitions Effectiveness Manuals (JMEMS), which determines how many rounds are required for a particular mission (Curry, 2013).
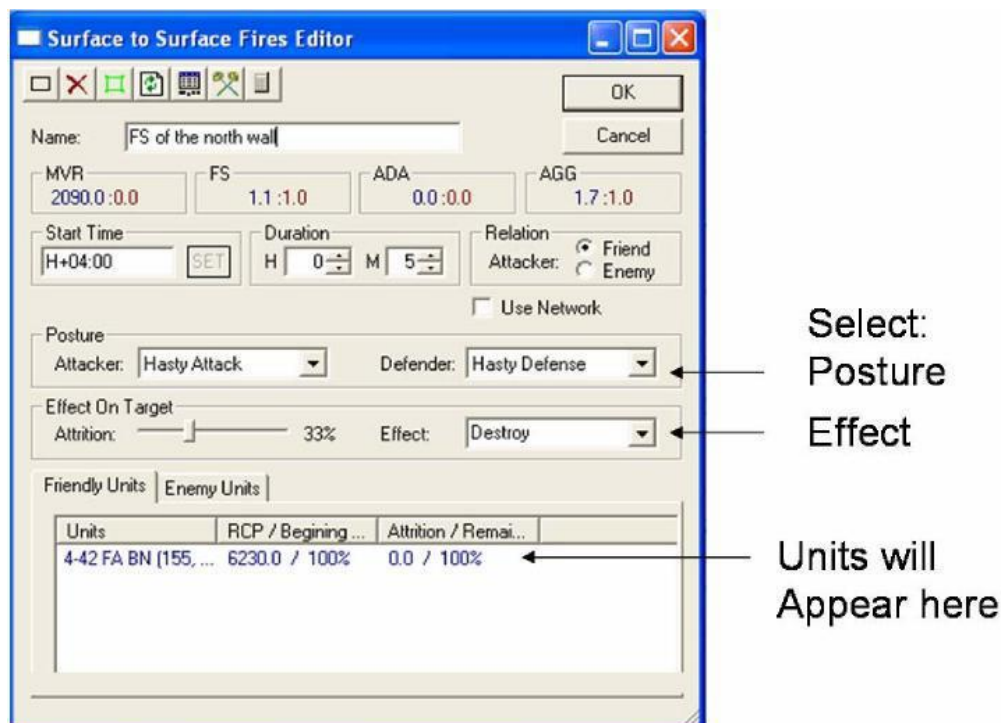
Figure 24.   Surface to Surface Fires Editor (from PAE Manual, 2013)

Furthermore, all combined arms combat calculations are resultant of the CGSC model (Curry, 2013). Curry (2013) continues to illustrate that this model compares overall RCP of the contending forces (direct fire + indirect fire + air defense fires) against one another and applies friendly and adversary force postures (hasty/deliberate attack,

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hasty/deliberate defense, meeting engagement and delay), the depth of the enemy defense, and the light conditions to determine the following.

- Attrition on both sides

- Victory or defeat status (used to determine recovery of damaged assets)

- Duration (how long it takes attacker to reach the rear of the enemy's defensive depth)

Indirect fires results are then determined by the platform level composition of the target unit, target effects desired, caliber and rounds being fired, and the posture of the target unit (PAE Manual, 2013). If a user changes duration or effect, the alternate value is modified. Having responsive analytics is extremely powerful when planners are engaged in wargaming as it provides clarity on ammunition management and the associated cost of a particular operation.

4. Air Strike

PAE has an air-to-ground attack module, which allows planners to specify an air attack of a ground target. PAE then examines the targets unit type and applies a munition's mix. As noted by Savinovich (2013), an infinite number of munitions mixes are available. PAE provides several mix options, such as three mixes for air defense (ADA) targets, one for air interdiction (AI) targets (bridges/buildings), four for armor targets, three for field artillery (FA) targets, two for infantry, and one for the ship (naval targets).

In an air strike (AS) simulation, PAE always flies two aircraft (A/C) (sorties per mission) and takes A/C from the nearest unit with A/C assets available. PAE then applies the munitions against the target array to determine the loss to the target (Savinovich, 2013). As illustrated in Figure 25, planners can override the results at the platform level, which provides a unique interface that allows planners to use their expertise (art of war) to enhance PAE's simulation power (science of war). This simulation power does not end with AS but is very robust in air assault (AA) planning.

Figure 25.   Air Attack Attributes Tab (from PAE Manual, 2013)

5.   Air Assault

The AA feature enables planners to simulate AA for missions like Helicopterborne Operations, which is one of PAE's special functions. As seen in Figure 26, the AA interface is intuitive and planners select the following sequence.

- Task (air assault)
- Select the target (landing zone)
- Select the execution matrix (start time)
- Enter Duration
- Click Create. A task (inverted arrow) appears in the execution matrix (PAE Manual, 2013).

Figure 26.   Air Assault Interface (from PAE Manual, 2013)
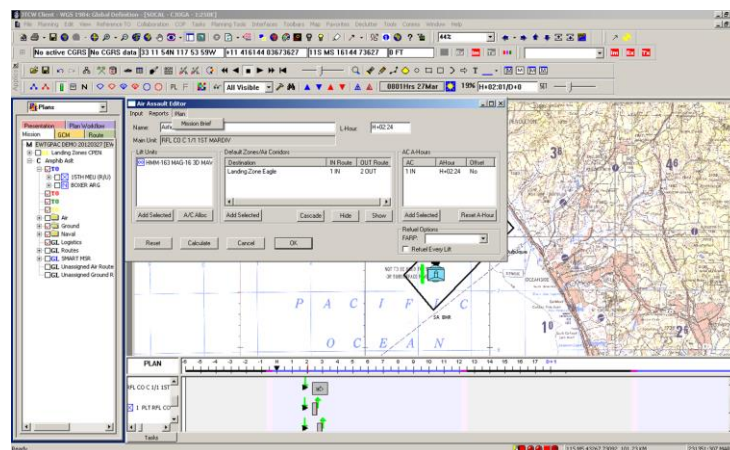
Figure 27 shows PAE does not just create graphics; it generates reports like zone diagram, which allows planners to select pickup or landing zones (PAE Manual, 2013). As Savinovich (2013) explains, PAE does not stop there. By entering the appropriate information, PAE allows planners to develop a route card that selects the air corridor, pickup zones (PZ), landing zone (LZ), checklist, and the air assault checklist. Furthermore, PAE will generate a GO/NO GO criteria for intel, maneuver, fires, ADA, main operating base (MOB)/Career Management Operations Branch (CMOB), CSS, C2, and if they have been completed (PAE Manual, 2013).

Figure 27.   Zone Diagram (from PAE Manual, 2013)

6.   Expeditionary Operations

Expeditionary operations is another one of PAE's special functions. The Expeditionary operations planning function allows planners the ability to plan amphibious, heloborne, or AA operations inside an overall tactical plan, as seen in Figure 28. Operations prior to, during, and after the assault are integrated in time, space, and unit

status (Savinovich, 2013). Planners are able to configure assault forces, amphibious shipping and landing craft, and aircraft to meet the expected state of forces at time of an assault. Plans menu provide users with report templates that kick start the order writing process like mission brief, ground command element (GCE) landing, landing field (LF) landing and aviation combat element (ACE)/LF aviation landing plan (PAE Manual, 2013).
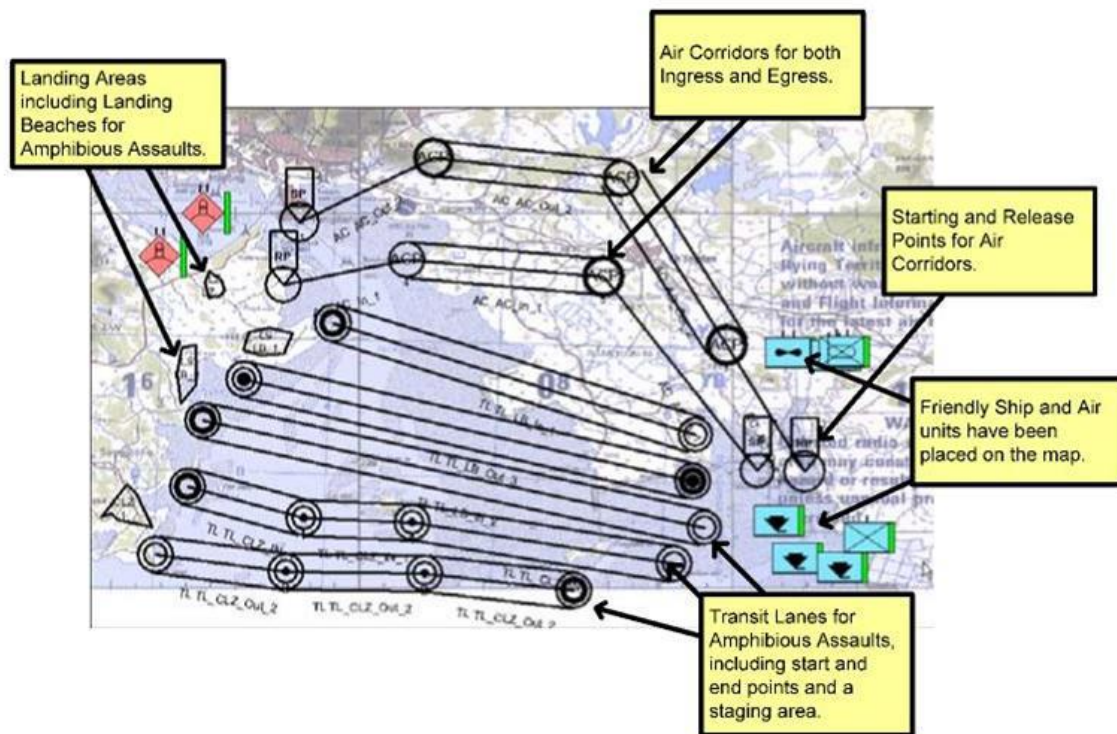
Figure 28.   Expeditionary Graphic Interface (from PAE Manual, 2013)

7.   Logistics

The planning application logistics features enable users to plan at both a high level (theater level) for general logistical requirements and at a low level (battalion or company) to assist the logistician at the tactical level (Savinovich, 2013). The logistics editor has various tabs that interact with each other and are based off the tactical plan. All units located on the map are considered when the logistical plan is created (PAE Manual, 2013). The PAE reasoning engine uses the logistical planning algorithms of both the

Marine Corps and the Army (Curry, 2013). Some of the algorithms are based on the personnel count and the location of the unit, others are based on the platforms of a unit, and still others are based on the unit. The outputs of the logistical calculations are expressed in pounds, gallons, or down to the appropriate national stock number (NSN), line item number (LIN) or table of allowance material control number (TAMCN) level of detail (Savinovich, 2013).

As Figure 29 illustrates, users may establish three support relationships: direct support (DS), area support (AS), and general support (GS). The calculation of supply requirements remain the same regardless of the support relationship, however, the load configuration is calculated for DS and GS units (PAE Manual, 2013).
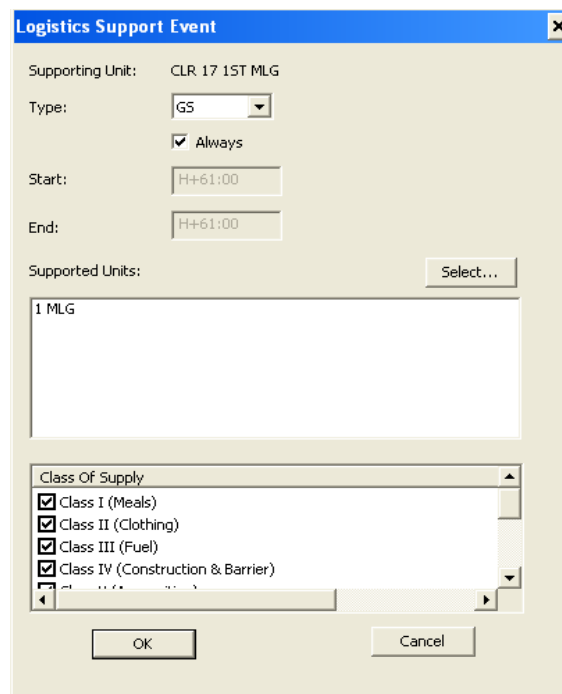
Figure 29.   Logistic Support GUI (from PAE Manual, 2013)

PAE understands and applies the principles of priority of support, priority of supply, and priority for maintenance to friendly forces as seen in Figure 30 (PAE, Manual, 2013). Defaults are set for priority of supply based off the general posture selected when the mission was created, and defaults for the maintenance priorities based

off the RCP factors (Savinovich, 2013). The defaults are applied to provide a departure point for planning or use in a time-constrained environment. The users can manually change the setting to reflect their needs (PAE, Manual, 2013). If the plan is divided into phases, different priorities can be established for the various phases.

Figure 30.   Logistic Priority Tab (from PAE Manual, 2013)

PAE's logistical release computes the calculation of Class I, II, IIIB, IV, VI, VII, and Class VIII to the company level of detail (Curry, 2013). The supplies are calculated to the pound, gallon or NSN level of detail, and are notionally placed on trucks based on the weight, cube, or volume, and delivered to a unit (PAE Manual, 2013). Figure 31 is a detailed XML printout by vehicle of the supplies required to support the forces down to company level (Savinovich, 2013).

Figure 31.   Logistics Report (from PAE Manual, 2013)

Logistic performance data comes from a variety of sources. The classes of material within PAE are described as follows, and are derived from the Strategic Planning Branch at Combined Arms Support Command (CASCOM), Ft. Lee, VA (Curry, 2013).

- Class I—Subsistence, gratuitous (free) health and comfort items
- Class II—Individual equipment, tentage, organizational tool sets and kits, hand tools, unclassified maps, administrative and housekeeping supplies, and equipment
- Class III—Petroleum, fuels, lubricants, hydraulic, and insulating oils
- Class IV—Construction materials, including installed equipment, and all fortification and barrier materials
- Class V—Ammunition of all types, bombs, explosives, mines, fuses, detonators, pyrotechnics, missiles, rockets, propellants, and associated items
- Class VI—Personal demand items
- Class VIII—Medical material

- Class IX—Repair parts and components to include kits, assemblies, and subassemblies
- Class X—Material to support nonmilitary programs, such as agriculture and economic development

Logistic performance data figures are mainly used to determine consumption based on headcount, operation, and climate conditions. An example is Class I values found in the Strategic Planning Factors Branch Handbook. Whereas Class III (bulk) is based on a much more precise formula in which the movement or normal operating costs of the unit are determined based on time or distance of movement, or activity, and are compared against the number of vehicles by type (Curry, 2013). Curry (2013) continues to explain it is calculated in real time. As the number of fuel burning platforms changes over time (combat losses vs. maintenance returns), so will the information provided to the planner.

As seen in Figure 32, Class I calculations consider the use of meals ready to eat (MRE) rations based on the tactical scenario and are editable by the user (PAE Manual, 2013). Class II, IV, VIII, and IX are calculated based on pounds per person per day. Class V (artillery only) is based on the planned targets and considers the destruction and target type. Class VI is based on headcount and scheduled for delivery every 10 days. Class VII is based on the planned loss rate after considering the correlation of forces matrix (COFM) output and maintenance repair times (PAE Manual, 2013).
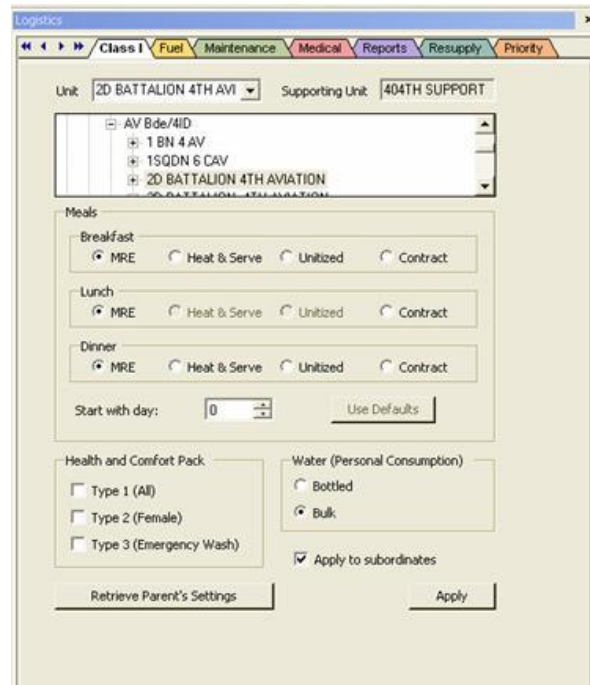
Figure 32.   Logistics Window—Class I Tab (from PAE Manual, 2013)

Delivery of supplies falls into two broad categories, from supplier to supplier, and from supplier to consumer. Deliveries of supplies from a supplier to supplier are often high demand or high usage items, and are based on an objective stockage level at any particular location (Savinovich, 2013). The timing of the delivery is based on the time distance factors of long haul (two trips a day) or short haul (four trips a day). For consumers, the delivery of rations and water is usually the driving factor for the delivery of all supplies. As such, consumers of supplies usually receive the supply distribution in the morning, afternoon, and evening hours near normal meal times (Savinovich, 2013). The resupply scheduler in PAE accommodates both suppliers and consumers as illustrated in Figure 33.

Figure 33. Logistics Window—Resupply Tab (Supplier to consumer left,
Supplier to Supplier right) (from PAE Manual, 2013)

Savinovich (2013) explains during planning, PAE automatically maintains the unit's status and provides planners a report of battle activity in which attrition of the asset is calculated. Maintenance teams then perform maintenance, and these resources are dynamically allocated during mission planning and execution. PAE uses the planning factors database to determine the amount of damage sustained by units during battle (Savinovich, 2013). Users can edit the values in the planning factors database to customize the data for their own mission (PAE Manual, 2013).

As seen in Figure 34, PAE used an Ordnance School Manual to obtain planning factors for severity of damage based on combat outcome and unit posture (Curry, 2013). In the example, the assets declared damaged went into a category: non-repairable, battle damage assessment and repair (BDAR), level 2, level 3 or theater level maintenance. The planner can set the hours required for repair at each echelon. If an adequate number of mechanics by type are provided in the appropriate maintenance units at the appropriate echelons, then the systems will be repaired according to the time requirements and returned to the owning unit (Savinovich, 2013).

Figure 34.   Planning Factors Maintenance Tab (from PAE Manual, 2013)

In Figure 35, PAE provides medical service awareness by importing data from the Fort Sam Houston U.S. Army Medical Command (MEDCOM) that distributes casualties between Levels 1 to 6 medical treatment facilities according to posture (Curry, 2013). If appropriate medical beds are available in the units, the casualties will be treated and returned to their units. If not enough beds are available, the casualties are sent to the next highest echelon of medical care (PAE Manual, 2013).

Figure 35.   Planning Factors—Medical Treatment Factors (from PAE Manual, 2013)

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Another collaborative tool in PAE as seen in Figure 36 is called the transportation window. As noted in the PAE Manual (2013), planners are provided with the current status of all transportation assets as determined by the time selected on the timeline and any transportation assets scheduled for use. The transportation window enables planners to forecast vehicle usage up to two hours before the time selected and up to four hours after the time selected (PAE Manual, 2013).
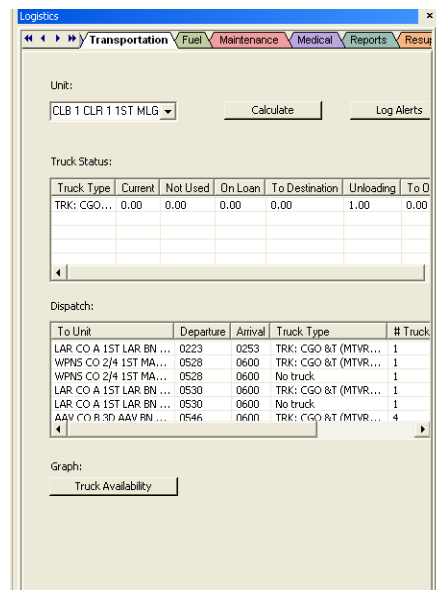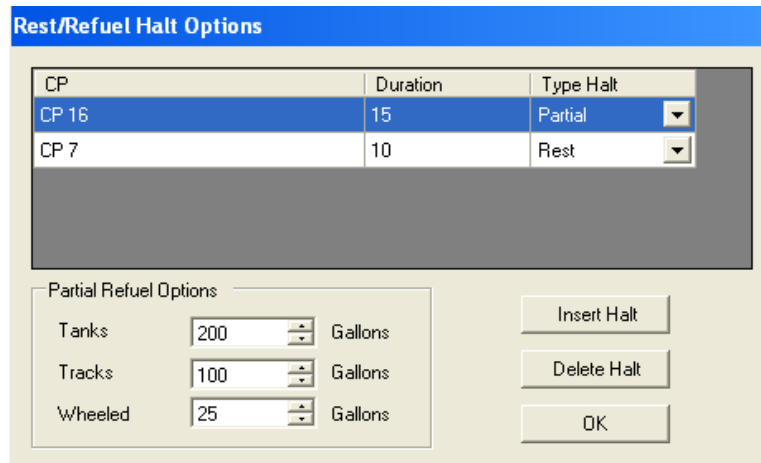

Figure 36.   Truck Availability (from PAE Manual, 2013)

Another behavioral model within PAE provides planners with the ability to predict when a unit needs to be refueled (Curry, 2013). The system determines the fuel pacing item (that platform that will run out of fuel first based on consumption vs. fuel tank capacity) (PAE Manual, 2013). As seen in Figure 37, when that asset reaches a planner's defined threshold (default is 30% remaining), the entire unit is refueled. The system sends a message to its refueling unit (predictively) and that unit sends out the necessary number of trucks (Savinovich, 2013). Savinovich (2013) continues to explain if either fuel storage or transport is not available, the system alerts the planner.

Figure 37.　Rest and Refuel Halt Options (from PAE Manual, 2013)

8.　Wargaming

One of the most dynamic features that PAE provides is automated and manually influenced play during wargaming as seen in Figure 38. Fundamentally, PAE provides planners with all the science of war and allows the planners to determine the success or failure of a COA (PAE Manual, 2013). Wargaming simulation assists the planner in creating multiple COA based on aforementioned behavioral and analytical models and then wargames them (Savinovich, 2013). At the end of the wargames, PAE will compare the wargames to determine which COA is stronger based on a series of criteria (mentioned above), which the user can modify, but again, it is the user that must determine the success or failure of a COA.

Figure 38.　Auto Wargame Dialog Box (from PAE Manual, 2013)

D.   HOW WILL THE PAE ALLOW COLLABORATION?

PAE provides a robust platform of collaborative tools. As mentioned previously, PAE enables real-time information to any planner regardless of geographical location. Unique capabilities that PAE brings to an OPT and staff that will help frame a complex environment are described as follows.

1.   Smart Routes

As seen in Figure 39, PAE enables planners to create smart routes, major supply routes (MSR) and alternate supply routes (ASR) with the start point (SP), check points (CP), and release points (RP) attached to them (PAE Manual, 2013). Planners simply place each CP on the map. PAE prompts the planner to associate it with the MSR and ASR if desired (Savinovich, 2013). These smart points allow the user to reuse the route segments and allow the user to navigate across the area of operations (AO) quickly (PAE Manual, 2013).

Figure 39.   Unit Movement Window (from PAE Manual, 2013)

During unit movements, the planner can determine the amount of time the unit will occupy road space, the passing time, clear times, length of the column, serial and march unit (Savinovich, 2013). As Figure 40 illustrates appropriate movement order, strip maps, convoy clearance requests (movement bid), and Excel spreadsheets are the output

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files provided by this window. Although designed for complete units, it can also be utilized for subunits or convoy operations.

| TO: | THRU: | FROM: | DATE: 22 Mar 2012 EXT # |

files provided by this window. Although designed for complete units, it can also be utilized for subunits or convoy operations.

Figure 40.   Movement Order (from PAE Manual, 2013)

Additionally, because of the high frequency of SIGACTS that occur along supply routes, an incident avoidance capability was created based on past SIGACTS to predict where and when to avoid certain route segments (Savinovich, 2013). Using the SIGACTS database, the convoy avoidance feature will allow the planners to see significant activities along the designated route. These activities can be filtered by time and day or date ,and choose the best time to travel the route, or have the software reroute the convoy to avoid potential danger areas or dangerous days or time, as seen in Figure 41 (PAE Manual, 2013).
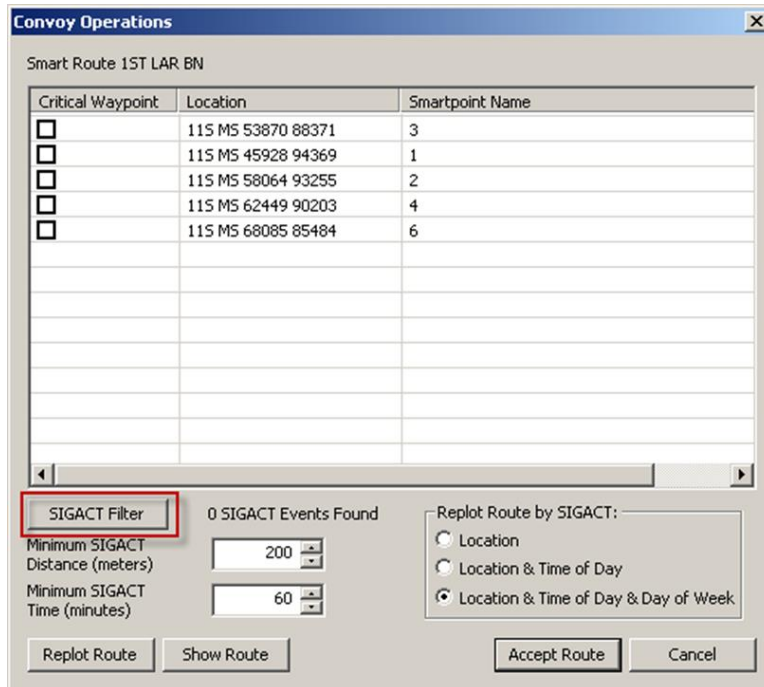
Figure 41.   Smart Route Waypoint (from PAE Manual, 2013)

2.   Political, Military, Economic, Social, Information, and Infrastructure

The PAE diplomatic, information, military, and economic (PMESII) interface details the features and concepts of the diplomatic, informational, military and/or economic (DIME)/PMESII functionality within the PAE (PAE Manual, 2013). PAE allows planners to load nodes and links from a local database to a mission. Furthermore, planners are able to import nodes and links from an external database and then perform centrality analysis for nodes and links as seen in Figure 42 (PAE Manual, 2013). This study provides planners a better awareness of 1st, 2nd, and 3rd orders of effects on either operations or a civilian populace (Savinovich, 2013).
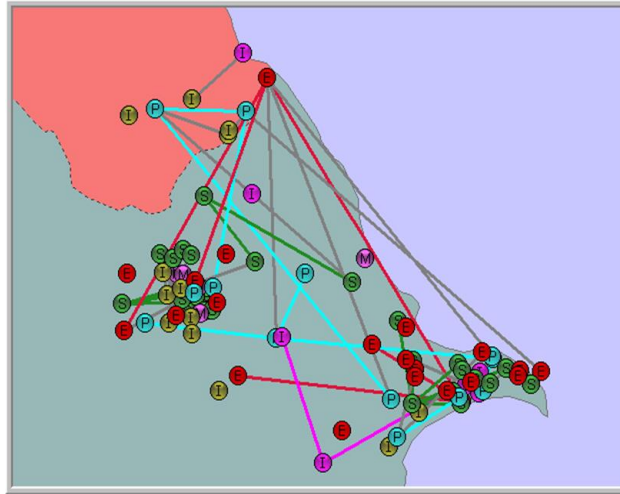
Figure 42.   DIME/PMESII (from Savinovich, 2013)

3.   Significant Actions (SIGACTS) Within PAE

In PAE, SIGACTS functionality provides users with the tools to view significant actions or lists of events for the region within a specified duration of time and location (Savinovich, 2013). The SIGACTS feature in PAE allows the user to view significant actions with user-defined filters and to correlate these actions to various calendars to help model predictions for future actions within an event type (PAE Manual, 2013).

For PAE, SIGACTS downloads all Combined Information Data Network Exchange (CIDNE) SIGACTS events from the CIDNE web service and stores them locally. As seen in Figure 43, PAE then displays these events visually on a map and tabs located in the Execution Matrix (PAE Manual, 2013). PAE can then predict what events might take place in the future based on past relevant data pertaining to a specific event and period (Savinovich, 2013).
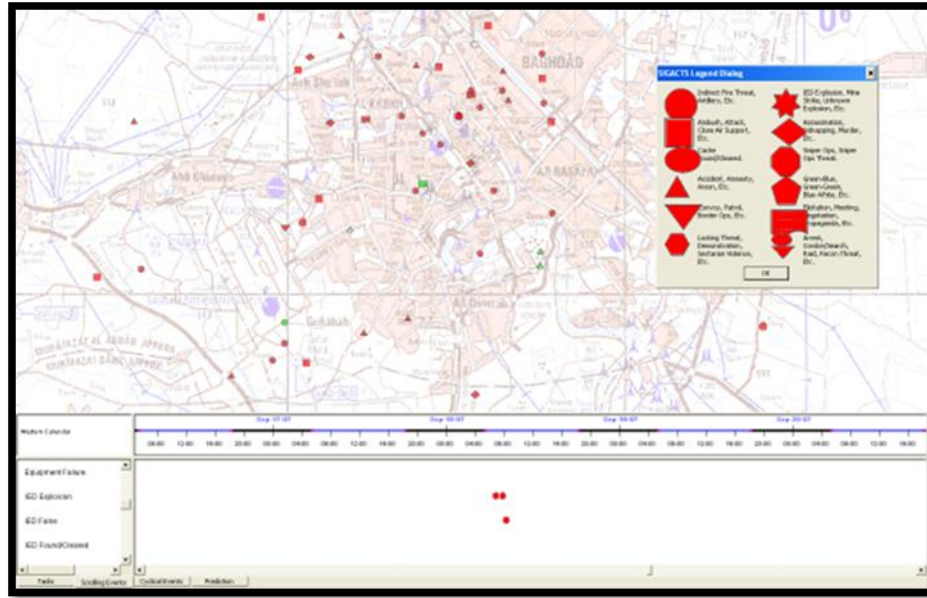
Figure 43.   SIGACTS (from Savinovich, 2013)

4.   Briefings, Orders Development, and Transition

Planning application has two methods for presenting, PowerPoint briefings and report features. Both methods can assist planners with writing an operations plan, or order and preparing for confirmation briefs (Savinovich, 2013). The briefings are done through the presentation tab and the logistics presentation tab under reports. Additionally, under reports, the software auto generates an OPLAN/operations order (OPORD), fragmentary order (FRAGO), warning order (WARNORD), task organization (TaskOrg), sync matrix, and annexes A, B, C, I, unknown and neutral, unit RCP, and AA as seen in Figure 44 (PAE Manual, 2013). The various reports can be accessed by clicking on Planning Tools/Reports/and then select the report desired. Microsoft Office must be installed to use the PAE reporting features (Savinovich, 2013).
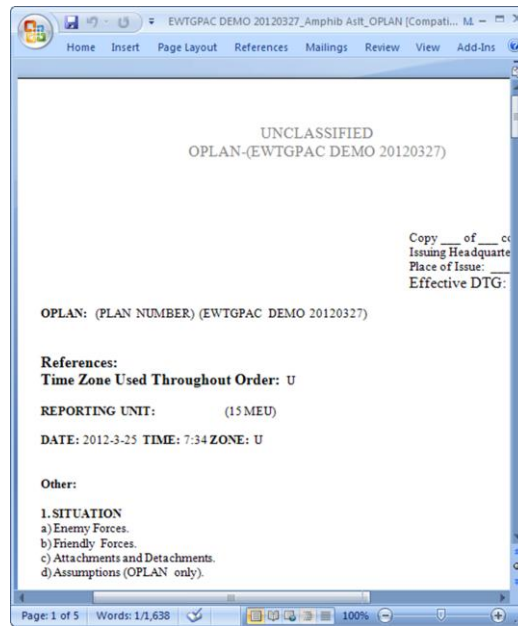
Figure 44.   OPLAN (from Savinovich, 2013)

5.   Summary

PAE provides a robust platform that leverages current C2 systems. PAE enables planners to establish a real-time collaborative environment, which continues to increase the post-adoption expectation or the usefulness of PAE, as seen when planners are able to provide better fidelity regardless of experience, and a forum for planners to expand awareness and skills. By using the aforementioned GUIs, the planner will be able to focus efforts toward the art of war that will provide the combatant commander a higher quality of information, and thus, increase the satisfaction of PAE as a viable innovation. PAE provides some concern that influence PAE's adoption. First, PAE's GUIs appear along the top of the application and are incorporated in the main JTCW toolbar, which increases the complexity of PAE. As seen in Figure 45, each of these concerns is an external variable that negatively affects the PU and PEOU of PAE and decreases the BI to adopt PAE. Next, using KVA analysis, this thesis examines if PAE provides benefits the commander, staffs, and planners.
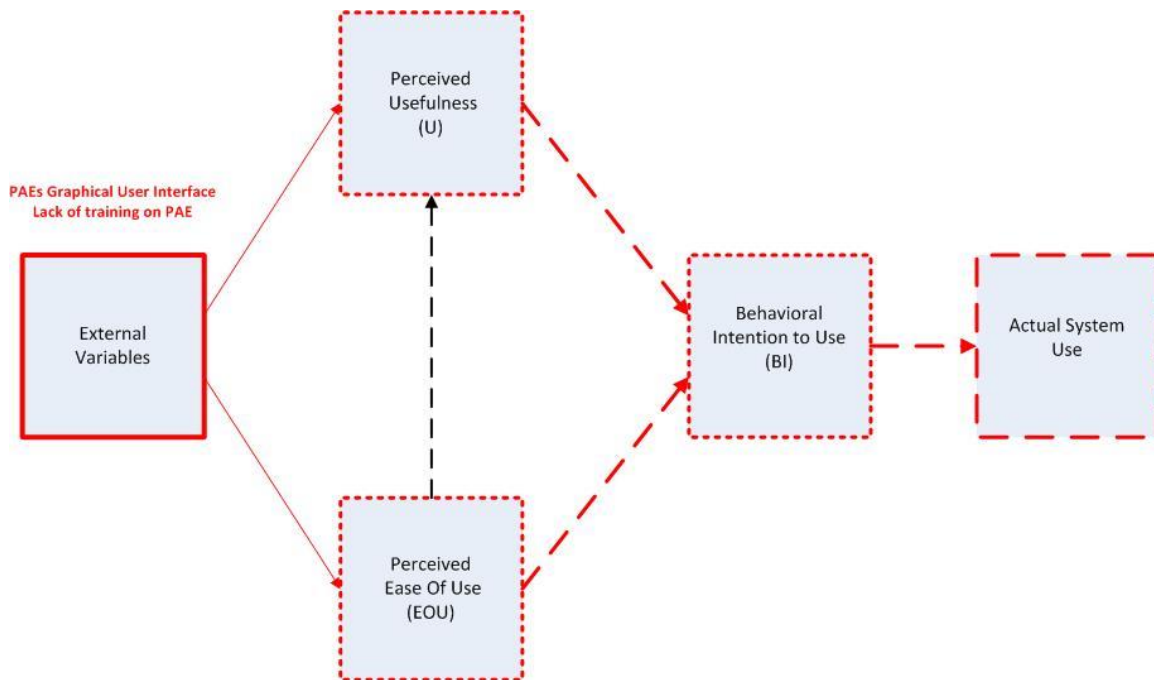
Figure 45.   Negative Influence External Variables on BI using TAM
(from Davis, 1989)

E.   HOW MUCH VALUE DOES PAE ADD TO R2P2?

The KVA methodology addresses the longstanding need of commanders and leaders to be able to measure the value of the knowledge that exists within employees, processes, and IT (Housel & Bell, 2001). A ROK ratio is produced by the KVA analysis, which shows the estimated value added by process assets to the final process output.

The focus of this KVA analysis is to examine the current (As-Is) Marine Corps R2P2) and through the use of business process reengineering (BPR) to identify areas to increase efficiencies within R2P2. As defined by O'Neill and Sohal (1999), BPR involves the fundamental analysis in current processes, structure, and information systems that will identify areas that can be radically improved or modified (e.g., time, cost, quality, and customer service).

The R2P2 planning process is the same as the MCPP with some modifications due to time constraints (MCWP 5-1, 2010). The problem framing step is essentially the same while COA development is limited to three COAs. The COA wargame is informal with two of the three COAs compared. Then, the confirmation brief constitutes the order,

and rehearsals are the primary means for subordinates to show understanding of what is needed in mission execution.

1. As-Is Process

R2P2 enables a unit (such as an MEU) to receive, analyze, plan, and coordinate a mission within six hours of notification. The standard is to commence the mission within six hours of tasking. Mission commencement does not necessarily mean actions on the objective, but simply taking step towards (launching R&S) achieving mission accomplishment. To achieve this MEU, the commander will establish three types of planning cells: crisis action team (CAT), battle staff, and mission planning cell (MPC) and will provide each planning cell their own planning spaces. The staffs know the roles and functions in each of the planning cells, which will allow simultaneous planning during R2P2.

Information flow must be a single point of contact, which will establish and control the flow of information. Additionally, developing execution checklists and smart-packs, and maintaining records of mission planning and execution all aid in effective information flow. As illustrated in Figure 46, upon receipt/acknowledgement of a WARNORD or an OPORD, the commander or designated individual establishes the CAT. The CAT builds awareness for the commander, which also allows the battle staff to be assembled and ready to receive the transfer of information from the CAT. Once the battle staff has received the information from the CAT, the information is analyzed and developed into a problem statement. Both the CAT and battle staff will then display all the information for the commander to approve. The assumption is that the commander will approve 90% and disapprove 10% of all problem statements.
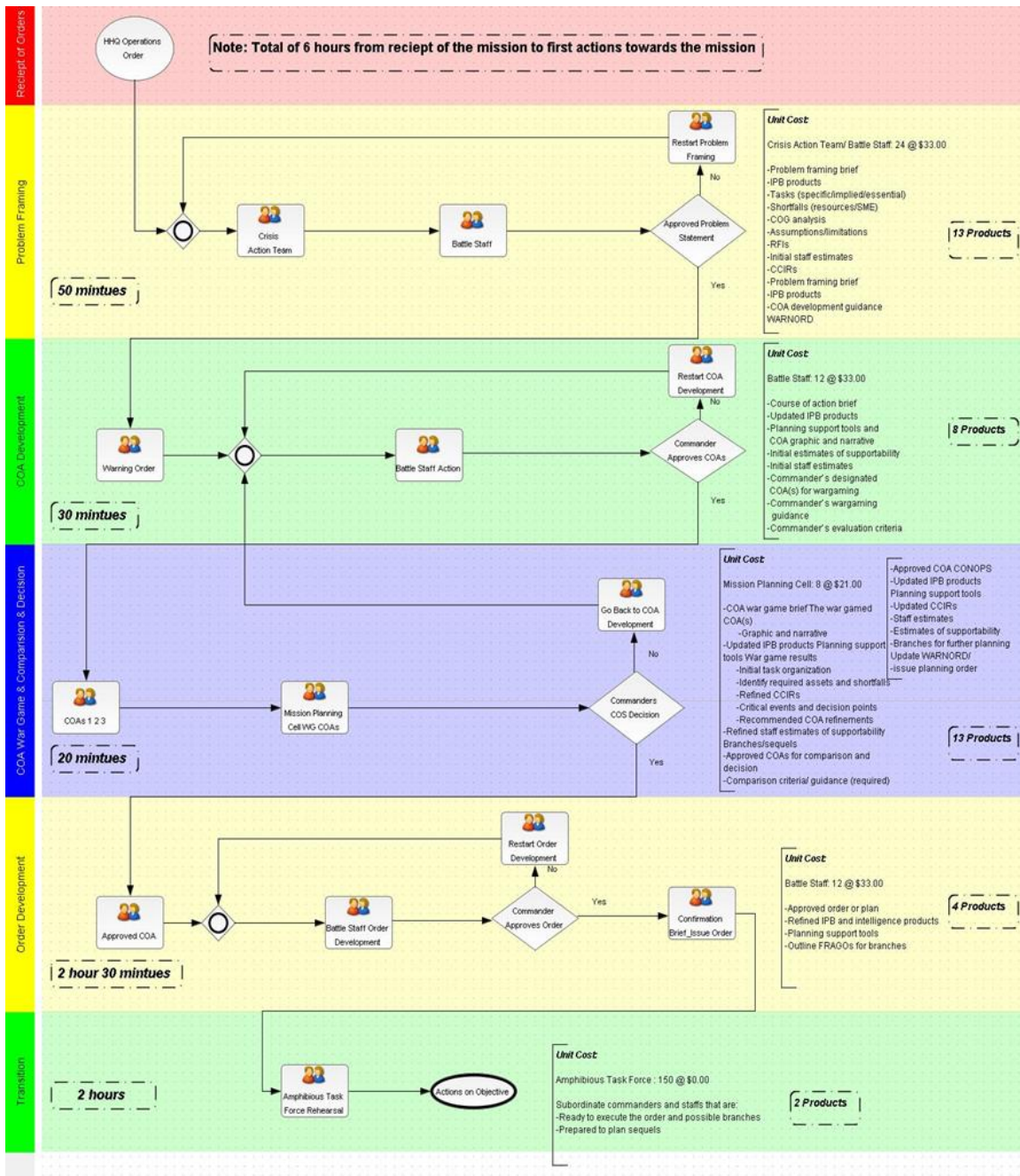
Figure 46.   Savvion Rapid Response Planning Process (R2P2) As-Is Model

Once the problem statement has been approved, a WARNORD is sent out for all other units to begin planning. At this point, the battle staff will develop three (COAs. Upon completion of all three COAs, the battle staff will again seek the commander's approval. During this phase, an assumption has been made that the commander will again

approve 90% and disapprove/modify 10% of all COAs. Once the COAs have been approved, the commander will activate the ,MPC), which will then wargame all three COAs and determine which COA will provide the best outcome for the mission/task. At this point, the MPC will provide a matrix that will compare all COAs and pursue the commander's approval. The same assumption has been made that the commander will again approve 90% and disapprove/modify 10% of a COA.

Once the commander has approved a COA, the battle staff will start orders development. During this phase, the battle staff will provide the writing document known as the OPORD. Once it is complete, the battle staff will request commander approval. During this phase, an assumption has been made that the commander will approve 80% and disapprove/modify 20% of the approved OPORDs. Once approved, the battle staff will provide a confirmation brief that will allow other units to walk through their OPORDs. Once the confirmation brief is complete, the transition phase begins. In the transition phase, the Amphibious Task Force will initiate rehearsals.

a.   *Personnel Assignment*

- Amphibious Task Force: (150 personnel @ $29/hour each)
- MEU staff   (100 personnel @ $35/hour each)
- Battle staff   (12 personnel @ $33/hour each)
- CAT   (12 personnel @ $33/hour each)
- MPC   (8 personnel @ $21/hour each)

Note: The Amphibious Task Force is not calculated for either utilization or cost. Furthermore, Amphibious Task Force has 2 hours of rehearsals, which are still accounted for in the overall six-hour requirement.

b.   *R2P2 Process Flow within Savvion*

Receipt of WARNORD   100% Complete

Problem Framing: 100% Complete
- CAT/battle staff develop awareness/problem (50 min)
- Statement
- Commander approves problem statement   10% (No)

	90% (Yes)
COA development	100% Complete
• Battle staff develops three COAs	(20 min)
• Commander approves all three COAs	10% (No)
	90% (Yes)
Course of action war game and comparison/decision	100% Complete
• Mission planning cell war games all three COAs	(20 min)
• Commander approves one COA	10% (No)
	90% (Yes)
Order development	100% Complete
• Battle staff develops operational order	(1 hour 30 min)
• Commander approves problem statement	20% (No)
	80% (Yes)
• Battle staff executes confirmation briefs	(1 hours)
Transition	100% Complete
• Amphibious Task Force rehearsal	(2 hours)

c. Assumptions for Simulation

- All software cost are already installed and accounted in cost
- All missions received are unique
- All staffs and planning cells understanding of the MCPP.
- All SOP are established and understood
- All C2 systems are functional and connected
- All planning groups have and understand responsibility and workspace location
- Each planning group will not have the same planners/personnel
- R2P2 will produce 40 different products to aid the Commander's decision cycle
- Confirmation Brief replaces a Doctrinal Operations Order
- One work day equals 12 hours

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- One week equals 84 hours

- One month equals 336 hours

- A six month deployment equals 2,016 hours

- Each deployment consists of 48 instances with 18 hours between each instance

- Each phase will have a normal distribution of 1 minute per staff function and phase transition

Table 1 shows the As-Is simulation results. After running 48 instances at a cost of $101,831.40 (excluding the Amphibious Task Force) with no waiting time and an overall time of 307 hours, the As-Is model performed at an average of six hours and 41 minutes. Furthermore, the personnel were utilized an average of .005% and no bottlenecks were identified.

KVA - No REVENUE

IT as a Minor Additive	
Hours Day	12
Actions/Day	0.42
Action/hour	0.035
Revenue per action	$ 12,000.00 Ref. Method Frameworks cost per session
Revenue/Day	$ 5,040.00

Reduction 1.00%

Sub-Processes	Actual Learning Time	Nominal Learning Time	Times Fired	#PEOPLE	%IT	Total Learning Time	Total Output per Day	Actual Work Time	Utilization per Day	Total Input per Day	Cost per day	NUM	DEN	ROK
Battle Staff Action	7	18	0.2359	4	50%	10.50	9.91	0.0021	0.0490%	0.0020	$132.00	$ 947.40	$0.26	3662%
Restart COA Development	4	1	0.0246	4	50%	6.00	0.59	0.2143	0.5282%	0.0211	$132.00	$ 56.56	$2.79	20%
Warning Order	3	1	0.1690	4	50%	4.50	3.04	0.0387	0.6543%	0.0262	$132.00	$ 290.89	$3.45	84%
Approved COA	2	1	0.2254	3	50%	3.00	2.03	0.1406	3.1690%	0.0951	$99.00	$ 193.92	$9.41	21%
Battle Staff Order Development	7	20	0.2535	3	50%	10.50	7.99	0.0032	0.0802%	0.0024	$99.00	$ 763.58	$0.24	3206%
Confirmation Brief_Issue Order	1	3	0.2254	3	50%	1.50	1.01	0.0834	1.8799%	0.0564	$99.00	$ 96.96	$5.58	17%
Restart Order Development	4	1	0.0282	3	50%	6.00	0.51	0.3750	1.0563%	0.0317	$99.00	$ 48.48	$3.14	15%
Battle Staff	6	15	0.0951	8	50%	9.00	6.85	0.0006	0.0056%	0.0004	$132.00	$ 654.49	$0.06	11117%
Crisis Action Team	6	14	0.0951	8	50%	9.00	6.85	0.0155	0.1473%	0.0118	$132.00	$ 654.49	$1.56	421%
Restart Problem Framing	2	1	0.0106	8	50%	3.00	0.25	0.0024	0.0025%	0.0002	$132.00	$ 24.24	$0.03	920%
COAs 1 2 3	3	1	0.1690	5	50%	4.50	3.80	0.0002	0.0031%	0.0002	$42.00	$ 363.61	$0.01	56739%
Go Back to COA Development	4	1	0.0845	2	50%	6.00	1.01	0.0009	0.0076%	0.0002	$80.00	$ 96.96	$0.01	7943%
Mission Planning Cell WG COAs	7	23	0.8451	1	50%	10.50	8.87	0.0023	0.1960%	0.0020	$130.00	$ 848.42	$0.25	3330%
Sum	56	100	N/A	56	N/A	84.00	53	N/A	N/A	0.2	1,440.0	$ 5,040.00	$26.79	188%
Correlation	89%													

Table 1.   Knowledge Value-Added (KVA) Result of As-Is Model

2. To-Be Process

After completion of the analysis of the "As-Is," it was determined that the total cost for the R2P2 process was greater than $101K (minus the Amphibious Task Force rehearsal cost). The first goal was to find an approach to reduce total cost by 25% or $25,457.85, while reducing the overall R2P2 process time from six hours to five hours. In addition, the team was directed to increase both battle staffs by 200%, as well as the utilization of the CAT. To meet these goals, the following two steps occurred, as illustrated in Figure 47.

- First step, the team removed half of the personnel from the CAT, and both battle staffs, which resulted in a personnel level of (12) CAT, and (six) in both battle staffs. By reducing the personnel, the overall savings for R2P2 was $62,675.10, which equals a 39% reduction in cost. Additionally, the team was able to meet the goal of increasing personnel utilization by 200% through a reduction in personnel. The To-Be analysis resulted in an increase from 0.147% to 0.799%, which is a 0.65% increase for the CAT. Concurrently, battle staff 1 increased from 0.049% to 0.729%, which resulted in a 0.68% increase. Finally, battle staff 2 increased from 0.080% to 11.80% to yield a significant 11.72% increase.

- Second step, the team automated the R2P2 process through the use of PAE. PAE was implemented in first four swim lanes (e.g., problem framing is a swim lane) at the start of each process, which resulted in a reduction in time from six hours to four hours and 44 minutes that resulted in a savings of one hour and 16 minutes. By injecting PAE at the start of each process, planning team and staffs are able to reduce staff actions on the science of planning and focus more on the art of planning. Thus, the staff leveraged PAE's ability to complete complex and mundane actions that traditionally erode time during R2P2 planning. This reduction in the science of planning allows an intuitive increase in time during the art or planning, and ultimately leads to a better thought out problem set with a higher quality return on performance on objectives.

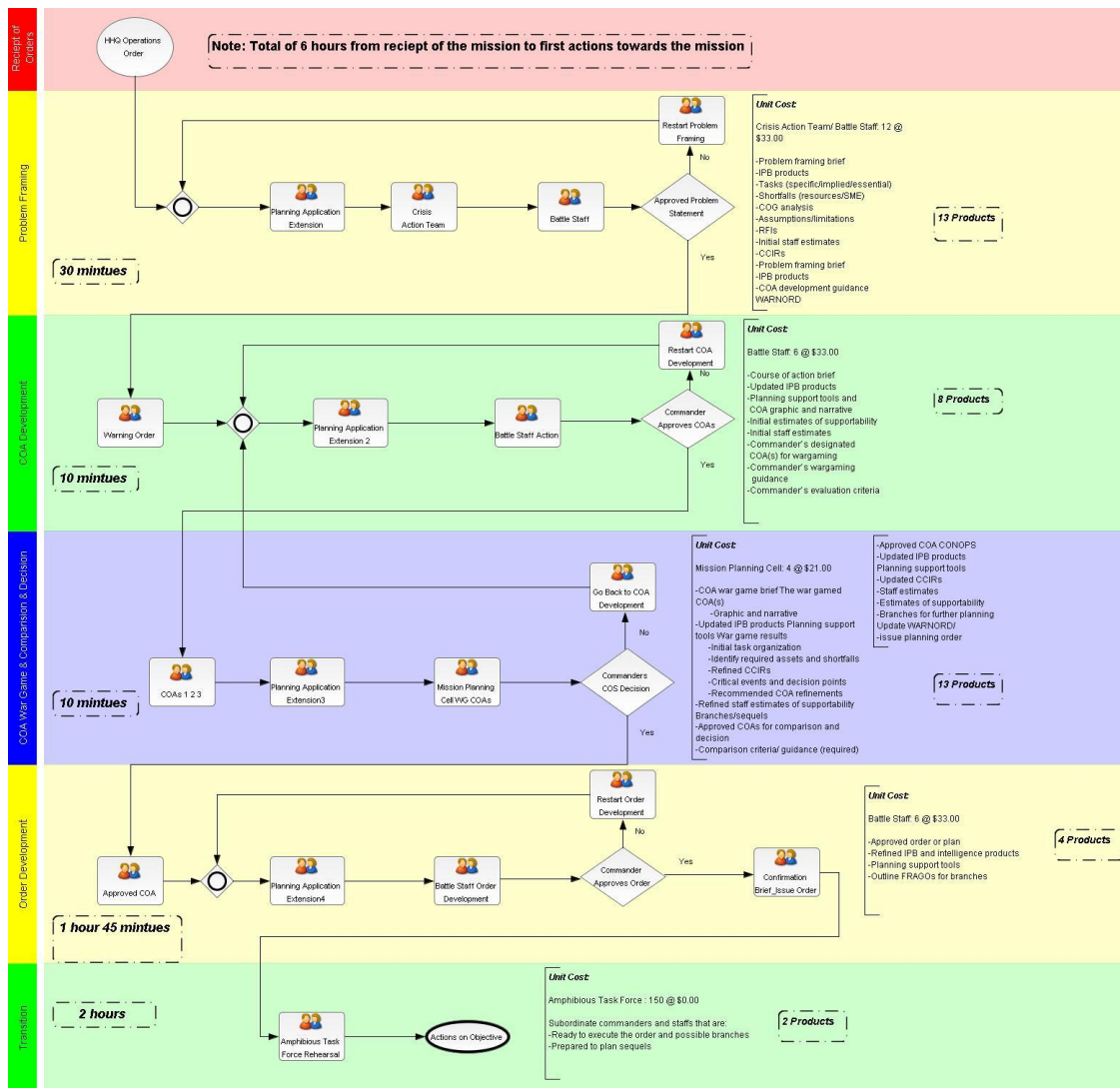Figure 47.   Savvion Rapid Response Planning Process (R2P2) To-Be Model

Table 2 shows To-Be simulation results. After running 48 instances at a cost of $62,675.10 (excluding the Amphibious Task Force cost) with no waiting time and an overall time of 227.26 hours, the To-Be model performed at an average of four hours and 44 minutes. Furthermore, the personnel were utilized an average of 0.026% and no bottlenecks were identified.

| | | | | | | | | KVA - No REVENUE | | | | | | |

KVA - No REVENUE

IT as a Minor Additive
Hours Day 12
Actions/Day 0.42
Action/hour 0.035
Revenue per action $ 12,000.00 Ref. Method Frameworks cost per session   Reduction 1.00%
Revenue/Day $ 5,040.00

Sub-Processes	Actual Learning Time	Nominal Learning Time	Times Fired	#PEOPLE	%IT	Total Learning Time	Total Output per Day	Actual Work Time	Utilization per Day	Total Input per Day	Cost per day	NUM	DEN	PAE ROK
Battle Staff	7	6	0.1383	5	50%	10.50	7.26	0.0136	0.3903%	0.00938	$132.00	$ 5,040.00	$1.24	4070%
Crisis Action Team	4	8	0.2833	5	50%	6.00	8.50	0.0278	0.7994%	0.03935	$132.00	$ 5,898.80	$5.19	1136%
Restart Problem Framing	1	1	0.5833	1	50%	1.50	0.88	0.1944	1.6458%	0.11343	$132.00	$ 607.23	$14.97	41%
Planning Application Extension	10	13	0.1167	1	50%	15.00	1.75	0.0023	0.3292%	0.00027	$99.00	$ 1,214.46	$0.03	45965%
Battle Staff Action	7	5	0.2583	3	50%	10.50	8.14	0.0136	0.7288%	0.01054	$99.00	$ 5,647.23	$1.04	5413%
Restart COA Development	1	1	0.0058	1	50%	1.50	0.01	0.0019	0.0165%	0.00001	$99.00	$ 6.07	$0.00	5408%
Warning Order	1	1	0.1192	1	50%	1.50	0.18	0.0025	0.3362%	0.00030	$99.00	$ 124.05	$0.03	4235%
Planning Application Extension 2	10	10	0.1250	1	50%	15.00	1.88	0.0022	0.3527%	0.00027	$132.00	$ 1,301.20	$0.04	35961%
COAs 1 2 3	6	8	0.1667	1	50%	9.00	1.50	0.0031	0.4702%	0.00051	$132.00	$ 1,040.96	$0.07	15331%
Go Back to COA Development	2	1	0.0100	1	50%	3.00	0.03	0.0017	0.0282%	0.00002	$132.00	$ 20.82	$0.00	9463%
Mission Planning Cell WG COAs	3	8	7.5833	1	50%	4.50	34.13	0.1404	21.3950%	1.06494	$42.00	$ 23,681.93	$44.73	529%
Planning Application Extension3	10	15	0.1167	1	50%	15.00	1.75	0.0022	0.3292%	0.00025	$80.00	$ 1,214.46	$0.02	60227%
Approved COA	3	1	0.0583	2	50%	4.50	0.53	0.0024	0.1646%	0.00028	$130.00	$ 364.34	$0.04	9883%
Planning Application Extension4	10	10	0.1167	1	50%	15.00	1.75	0.0023	0.3292%	0.00027	$130.00	$ 1,214.46	$0.04	34317%
Restart Order Development	1	1	0.0042	1	50%	1.50	0.01	0.0021	0.0118%	0.00001	$130.00	$ 4.34	$0.00	3844%
Battle Staff Order Development	7	8	4.1833	1	50%	10.50	43.93	0.0837	11.8025%	0.35001	$130.00	$ 30,482.89	$45.50	670%
Confirmation Brief_Issue Order	1	3	2.0000	1	50%	1.50	3.00	0.0417	5.6426%	0.08333	$130.00	$ 2,081.93	$10.83	192%
Sum	55	100	N/A	13	N/A	82.50	89	N/A	N/A	1.5	1,366.0	$ 61,537.45	$101.29	608%
Correlation	88%													

Table 2.   Knowledge Value-Added (KVA) Result of To-Be Model

3.   Conclusion

By reducing personnel and implementing PAE into the R2P2 planning process, the results found were quite insightful. This achievement offers further confirmation that PAE is a valid software innovation and must be used in today's complex environment. As illustrated in Table 3, the goals were achieved when PAE was implemented into the R2P2 process. Specifically, the team analyzed the As-Is model, using KVA, that identified a significant amount of slack that contributed to low utilization percentage. Conversely, adding PAE and reducing personnel across the board achieved a reduction in overall cost, a decrease in processing time, and an increase in utilization.

As-Is Processes	As-Is ROK	Utilization per Day	To-Be Processes	To-Be ROK	Utilization per Day
Battle Staff Action 1	3662%	0.049%	Battle Staff Action 1	5413%	0.729%
Restart COA Development	20%		Restart COA Development	5408%	
Warning Order	84%		Warning Order	4235%	
			Planning Application Extension 2	35961%	
Approved COA	21%		Approved COA	9883%	
			Planning Application Extension4	34317%	
Restart Order Development	15%		Restart Order Development	3844%	
Battle Staff 2 Order Development	3206%	0.080%	Battle Staff Order 2 Development	670%	11.803%
Confirmation Brief_Issue Order	17%		Confirmation Brief_Issue Order	192%	
Battle Staff	11117%		Battle Staff 1	4070%	
Crisis Action Team	421%	0.147%	Crisis Action Team	1136%	0.799%
Restart Problem Framing	920%		Restart Problem Framing	41%	
			Planning Application Extension	45965%	
COAs 1 2 3	56739%		COAs 1 2 3	15331%	
Go Back to COA Development	7943%		Go Back to COA Development	9463%	
Mission Planning Cell WG COAs	3330%		Mission Planning Cell WG COAs	529%	
			Planning Application Extension3	60227%	
Sum	188%	N/A	**Sum**	608%	N/A

As-Is Cost	To-Be Cost
$101,831.40	$62,675.10

As-Is Time	To-Be Time
6:25	4:44

Goals

1. Total Cost Reduction of 25% ($25,457.85) — $39,156.30

2. Ruduce the As-Is time by 1 hour (5 hours) — 1:41

3. Increase utilization of CAT/Battle Staffs by 200%
CAT (0.29%)	0.65%
Battle Staff 1 (0.10%)	0.68%
Battle Staff 2 (0.16%)	11.72%

Table 3.   As-Is versus To-Be R2P2 Model

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V. CONCLUSION/RECOMMENDATIONS

A. CONCLUSION

Innovations in software can provide organizations a platform to establish a collaborative environment that leverages new technologies. The Marine Corps must look at existing innovations that can link current systems to decision makers. As today's technology has advanced, the Marine Corps' duty is to capture innovations that will provide a better collaborative environment. This collaborative environment, and specifically C2 systems, must facilitate information retrieval at all levels while maintaining the authoritative integrity.

This thesis established a starting point that will provide information on collaborative software currently employed within a MAGTF. Additionally, this thesis examined how the PAE can efficiently improve information sharing during an OPT session. Having this context of how real time information empowers the commander, staffs, and planners will deliver a quality of information for increased operational awareness. Furthermore, through the lens of the TAM, the element that helps distinguish the technology adoption problem within the Marine Corps was identified.

B. FINDINGS

Thesis finding indicates that the PAE—a layer seven software extension—can be highly effective if properly implemented and staffs and planners are trained. PAE provides many positive attributes. First, PAE has a powerful platform for wargaming through the use of AI. The AI within PAE is a complicated computation of algorithms and behavioral models that enable multiple COAs to be analyzed and simulated against enemy and friendly RCP, which is significant in enhancing the user's PU and post-adoption expectations as seen in the TAM.

Second, PAE empowers commanders to simulate each COA and provide immediate feedback with highly responsive staff action, which allows staff and planners to make real time changes regardless of geographic location. As seen, this immediate feedback increases the knowledge of PAE that increases the perception of usefulness as

defined by Davis (1989). Finally, PAE has shown many benefits during a KVA simulation. By using R2P2 as a simple process for the KVA simulation, PAE enabled a 50% reduction in staffing of a standard MEU, and a cost reduction per planning processes of 39% was achieved. Additionally, PAE enables the standard six hours R2P2 process to decrease to four hours and 44 minutes, which saved one 1 hour and 16 minutes. These results are significant as seen in TAM; the adoption of technology is closely tied to the pre-conceived notions about the costs or benefits. As seen after using PAE, the post-adoption expectations is very high. PAE provides a combatant commander cost savings while reducing planning time that will positively affect its adoption.

Conversely, PAE does have some negative attributes that have affected its overall adoption. First, PAE is not widely known, as seen with only 70 Marines having been trained since 2009, which has greatly affected PAE's PU and EOU. Having minimal knowledge has led to missed opportunities for other values, such as persuasion, decision, implementation, and confirmation. Second, although the TAM is used, the perceived ease is affected by PAE's user interface, which is complex and not intuitive if not formally trained on it. Awareness and user interface are external variables that have greatly affected PAE's adoption rate.

C.   RECOMMENDATIONS

Thesis recommendations are that PAE becomes software of record to provide continuity in the execution of MCPP regardless of geographic location. MAGTF MSTP should incorporate PAE in future MAGTF training, both integrated into the current curriculum and through distance learning. Furthermore, an updated PAE GUI is necessary that will provide an intuitive experience and influence the PEOU for the user.

D.   FURTHER RESEARCH

This thesis is a starting point to begin a conversation about current software platforms underutilized within the Marine Corps. This thesis revealed three major areas for research in the author's opinion. First, more research is needed regarding current software to leverage existing C2 systems, specifically in the application layer of the OSI model. This research could potentially enhance the Marine Corps' warfighting

capabilities and operational reach of the combatant commander in the current fiscal environment. Second, the Marine Corps should complete an examination of C2 platforms that degrade existing C2 systems while negatively affecting warfighting capabilities. This analysis will provide context in cost reduction for future C2 systems. Third, more research is needed using systems analysis to identify gaps within the Marine Corps' current C2 network. This analysis will provide a foundation for current and future software platform design and security requirements. Last, conduct an in-depth study on technology adoption within the Marine Corps to frame institutional norms that affect technology design, implementation, and usage.

APPENDIX. THESIS DESIGN

Title: AUTOMATION OF THE MARINE CORPS PLANNING PROCESS

Theories/Model	Software Requirements	Marine Corps Planning Process	MAGTF C2 Systems	Planning Application Extension (PAE)	Analysis of PAE	Analysis of Adoption Problem
Chapter III	Chapter II, III & IV	Chapter II	Chapter III	Chapter IV	Chapter V	Chapter V
Technology Acceptance Theory	Command & Control	Problem Framing	**Command & Control:** JTCW, CPOF, IOSv1	Planning Assistant; Briefings; Order Development; Transition	**Positive**	Technology Acceptance Model (TAM)
Design Theory	Maneuver	COA Development	**Maneuver:** JTCW, JBV, BFT	Relative Combat Power (RCP); Battle Duration; War Gaming	• Powerful platform for war gaming through the use of Artificial Intelligence (AI).	**Positive**
Marine Corps Planning Theory	Fire Support	COA War-Game	**Fire Support:** JTCW, TBMCS, EMT, AFATDS, JADICS, PSS-SOF, StrikeLink	Indirect Fire; Air Strike; Air Assault; Expeditionary Operations	• Allows simulation against enemy and friendly Relative Combat Power (RCP).	**-Perceived usefulness:** PAE is designed from military doctrine which provides a comprehensive step-by-step automation of MCPP.
Technology Acceptance Model	Intelligence	COA Comparison & Decision	**Intelligence:** CIDNE, IOSv2, IOSv3, MarineLink	SIGACTS; PMESII; War Gaming	• Provide immediate feedback with highly responsive staff action which allows staff and planners to make real time changes regardless of geographic location.	**-Perceived Ease:** Through the use of Artificial Intelligence (AI) PAE allows COA Wargaming to be simulated. This provides staff, planners more time to focus on the art of war while PAE leverages the science of war.
Knowledge Value Added (KVA)	Logistics	Order Development	**Logistics:** CLC2S, TCPT, BCS3, IDE/GTN/IGC, RF-ITV, IBS CMM, SMS/DTS	Logistic Report; Truck Availability; Rest Refuel; Smart Routes	• Saves Time and reduces cost during operations.	**Negative**
	Force Protection	Transition	**Force Protection:** GBOSS, BAT/HIIDE, JWARN	PMESII; RCP; Smart Routes; War Gaming	• Links MAGTF C2 Systems through JTCW.	**-Perceived usefulness:** PAE is weak analytics in Force Protections which can effect PAEs usefulness.
					Negative	**-Perceived ease** is effected by PAEs user interface which is complex and not intuitive if not formally trained.
					• Difficult user interface. • Weak analytics in Force Protections • Not intuitive on Start-up-must have training on JTCW	

Chapter III

Chapter II, III & IV

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